JOURNAL OF DAIRY SCIENCE

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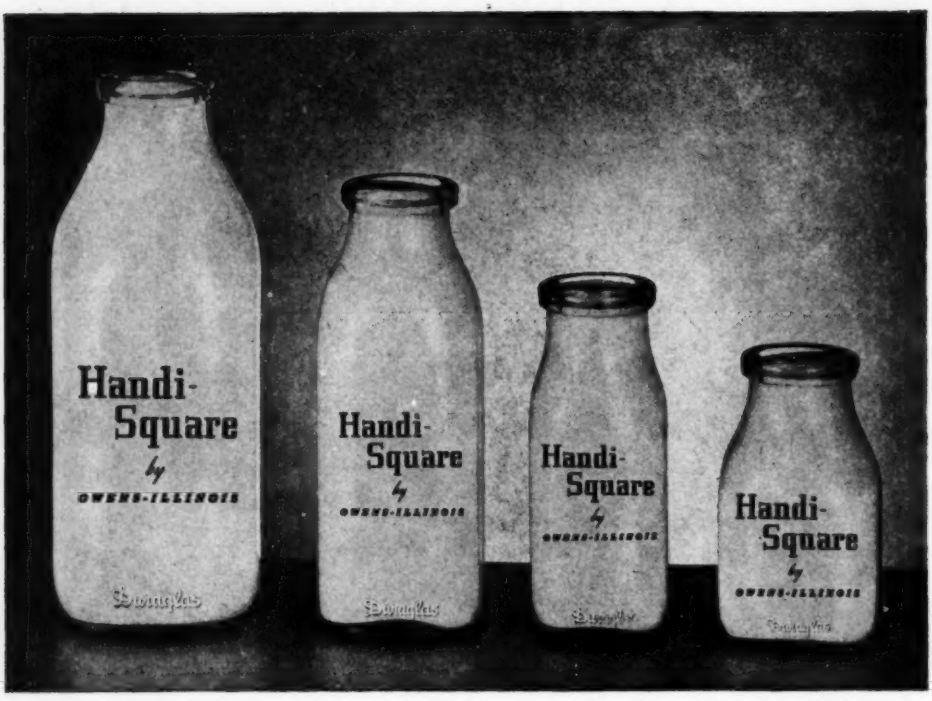

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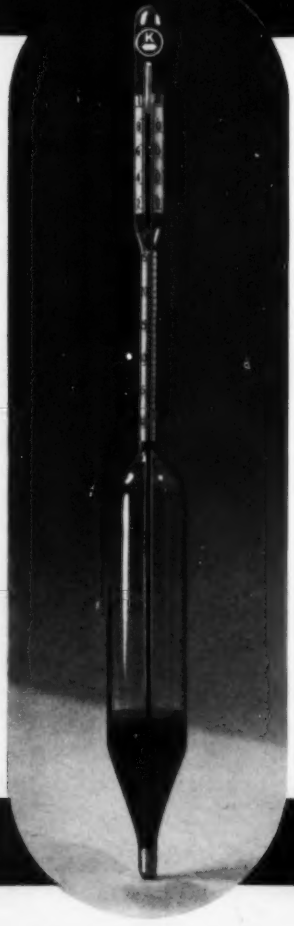

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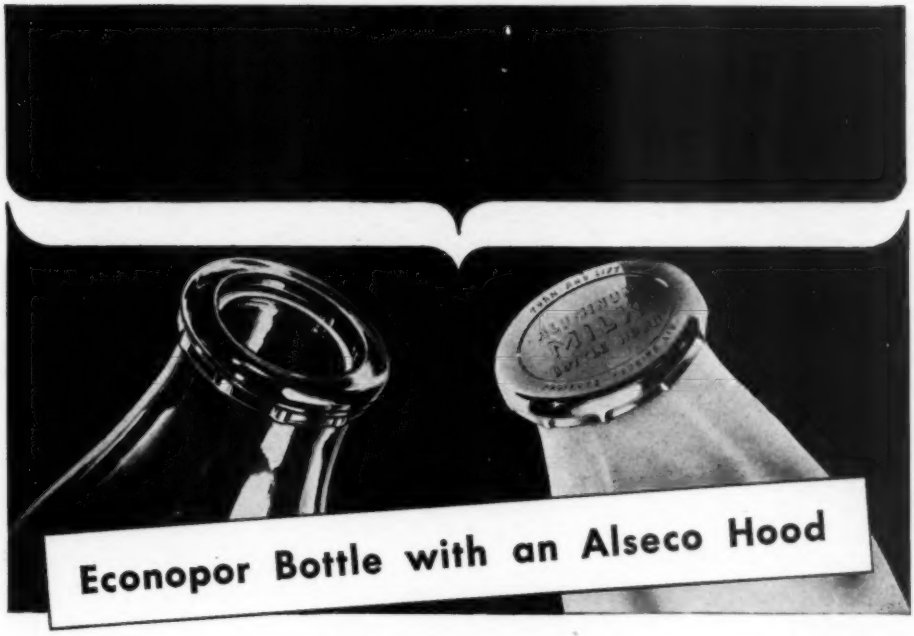

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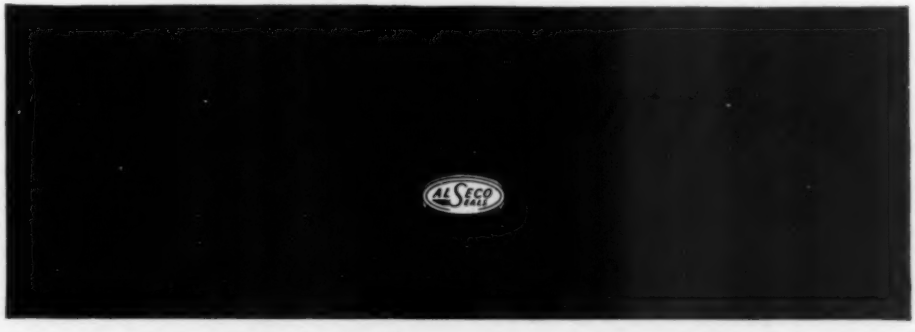

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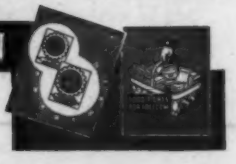

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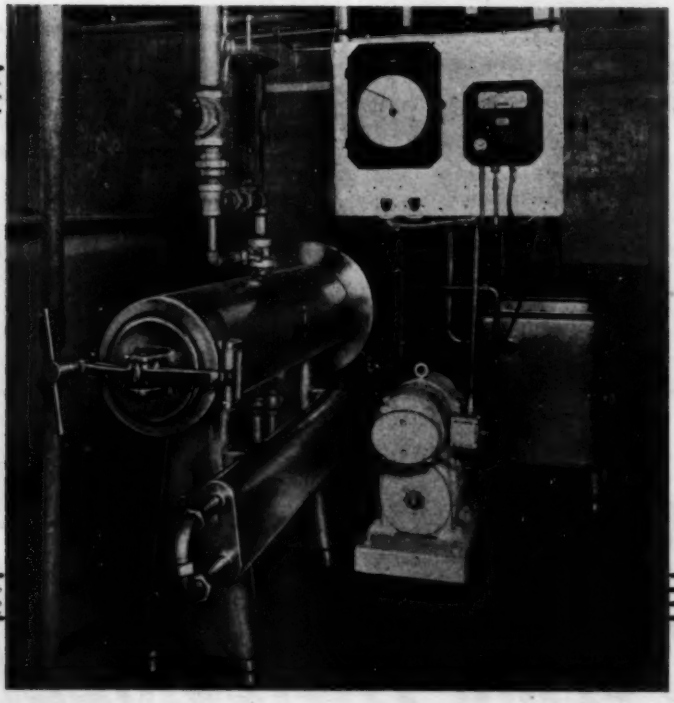

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JOURNAL OF DAIRY SCIENCE

VOLUME XXVIII OCTOBER, 1945 NUMBER 10

POST-WAR UTILIZATION OF DAIRY PRODUCTS*

G. C. NORTH, H. H. SOMMER, P. F. SHARP AND L. K. RIGGS, *Chairman*
American Dairy Science Association Committee on Post-War Dairy Manufacturing

It is the aim of this report to point out some of the changes that have taken place in the production and utilization of various dairy products during World War II, and to project some thoughts as to how these changes may affect the dairy manufacturing industry in its utilization of milk in the post-war period.

Because of the tremendous quantities of certain highly concentrated dairy products, such as milk powder, cheese, etc., needed in the feeding of our armed forces, and supplying our Allies in the form of Lend-Lease shipments, the total production of milk has been greatly increased and there have been significant shifts in the utilization of the total milk production. The importance of milk and milk products in modern nutrition is quite generally acknowledged, and this accounts for the inclusion of large quantities of dairy products in both the military and Lend-Lease programs. Furthermore, because of the scarcity of other foods, and the high purchasing power of the consumer, the quantities of fresh milk consumed has reached new high levels. Our cow population has reached an all-time high peak, and we will emerge from the war period with tremendous producing capacities.

One of the noticeable trends involved in the utilization of this all-time high production of milk is the shift in some important areas to the marketing of whole milk directly from the farm, as compared to the sale of cream. Many areas that formerly were not equipped with milk cooling facilities now have the necessary facilities to handle whole milk. It is therefore at once evident that tremendous quantities of milk solids not fat will be available to the dairy manufacturing industry that prior to the war were maintained on the farm and fed to livestock. It has been estimated that 8 to 10 billion pounds of such milk may contribute to a post-war surplus.

As already pointed out, the demands of our military forces and Lend-Lease have during the past few years caused a shift in the utilization of the milk production of the United States.

* Report prepared for the 1945 meeting of the American Dairy Science Association which was cancelled because of war travel and housing conditions.

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The table shown on this page shows the utilization of milk in the United States (1938 as compared with 1943 and 1944).

DRIED MILK

Milk powder production is perhaps the most outstanding example of the shift in milk utilization. In 1939 the production of non-fat milk solids for human food was about 268 million pounds and skim milk powder for animal feed 140 million pounds. In 1942, production of non-fat milk solids for human use was about 565 million pounds and approximately 61 million pounds of skim milk powder for animal feed.

Whole milk powder has increased from approximately 13,500,000 pounds

Utilization of milk in United States
(000,000 omitted)

Utilization	1938	1943	1944*
Factory and dairy products:			
Creamery butter	35,685	33,566	29,900
Cheese	7,250	9,765	10,100
Evaporated milk	4,490	6,608	7,450
Miscellaneous	4,022	5,895	7,210
Total	51,447	55,834	54,660
Fluid use:			
In cities and villages	32,408	42,299	44,426
On farms	11,950	11,630	11,718
Farm use:			
Farm butter	9,173	6,836	6,608
Fed to calves	2,850	3,277	3,274
Other uses	805	1,090	1,192
Totals	108,633	120,963	121,878

* These figures became available after this report was written and may be subject to some revision. (Editor.)

in 1937 to 125,000,000 pounds in 1943. Cheddar cheese production increased from 509,000,000 pounds (average from 1935 to 1939) to 916,000,000 pounds in 1942. Evaporated milk production increased from 2,000,000 pounds (average from 1935 to 1939) to 3,500,000 pounds in 1942.

Most of the increased production of milk powder has been brought about by the installation of new dehydrating equipment, the construction of new plants and more complete utilization of equipment already available. Dehydrating plants are quite costly and represent a very sizeable investment. Both powdered whole milk and non-fat milk solids production have been very greatly increased. Even though powdered whole milk may be produced in sizeable quantities in the post-war period for an expanding domestic market, and to some extent, for export, the total amount of milk that will be required for the manufacture of this product will probably be a relatively small percentage of the total milk produced. Non-fat dry milk

solids must therefore be looked upon as the probable outlet for large quantities of skim milk available in the post-war period. It has been estimated that the total hourly capacity of drying plants in the United States, including egg drying plants which are convertible for milk, is approximately 422,000 pounds per hour. Thus in spite of seasonal peaks and valleys of availability of milks for drying, there still exists an enormous production capacity. It also seems logical to conclude that when the demands for other types of dairy products become less at the end of the war, much milk will be forced into cream and non-fat dry milk solids. It is also generally conceded that the return of skim milk to farmers is not an economically sound procedure. A return to this practice should be eliminated insofar as practicable.

BUTTER

On account of the greatly increased wartime demands for exportable dairy products, butter production has been necessarily reduced. This is especially true in certain areas noted for the production of high grade butter. There is every reason to believe that the American public will cordially welcome the return of butter after the war.

During the war, because of the butter shortage, conditions have necessitated the increase in utilization of oil crops in this country, and their manufacture into products, such as oleomargarine. The fortification of oleomargarine with Vitamin A has been generally practiced and recognized by the Food and Drug Administration. Because of the low point value of oleomargarine, and the shortage of butter, oleomargarine consumption has greatly increased, and the fortified product, along with butter, has been included in the "seven basic food groups." Likewise an improvement in the quality of oleomargarine has tended to increase its consumption. Further improvements will undoubtedly be made in the future. We must not underestimate competition of oleomargarine with butter in the post-war period. This competition is likely to be especially sharp between oleomargarine and the lower grades of butter. Fine, high-score butter is still and always will be in a class by itself. Such butter need have little fear of competition.

CHEESE

The war years have been a period of increased cheese production and this has been accomplished without any very great increase in construction of new plants and equipment. There has also been a rather striking expansion of cheese-producing areas. Cheddar cheese quality has not suffered during the war. As a matter of fact, the proportional production of U. S. No. 1 cheese has increased. On the other hand, fine aged cheese has all but disappeared from consumer markets, because of immediate demands and the lack of a price differential in favor of aged cheese. The post-war domestic

consumption of cheese can be greatly expanded by means of high quality, more fine aged cheese and more cheese varieties.

EVAPORATED MILK

War demands have placed heavy responsibilities upon the evaporated milk industry. In the pre-war year of 1940 domestic production of evaporated milk was, in round figures, 56 million cases. Government agencies acquired only four million cases of that total. In 1945, the industry is pointing toward a production of 90 million cases, of which only 50% will go to the armed forces and other government agencies. The increase in production has been achieved without substantial addition to pre-war plant facilities. The quality of evaporated milk has been definitely improved by reason of general adoption by manufacturers of new methods of Vitamin D fortification. The rationing program has restricted domestic use far below civilian consumer demands. It is anticipated that an unrestricted post-war domestic market can absorb a substantial part of the wartime increased production.

ICE CREAM

The ice cream manufacturer, quite generally, believes that there will be a marked increase in consumption of ice cream in the post-war period. In many instances there has not been enough ice cream available to satisfy current consumer demands during the war period. There has also been the general shortage of ingredients for ice cream, which has made it rather difficult for most manufacturers to prepare ice cream of the quality that they desire. This has been generally recognized by consumers and there is a feeling based upon this situation that a marked increase in demand for good ice cream will be evident in the post-war period.

There has also been considerable planning by many ice cream manufacturers to develop improved types of ice cream to place upon the market in the post-war period. There will be no problem whatever in the increased use of non-fat dry milk solids by the ice cream industry, for it has been an accepted policy to utilize such solids to the very limit that seemed to give the best possible quality in the finished product.

It is also clear that the boys in the Armed Forces as they have been at the fighting fronts and as they returned to this country have been particularly appreciative of good quality ice cream—one of the first foods which they have often requested upon return to the United States.

NON FAT DRY MILK SOLIDS

Because of the valuable nutritive properties of non-fat dry milk solids, it seems natural that they should be utilized as a human food, both from the nutritive standpoint, as well as their possibilities for the best financial returns to the farmer. Undoubtedly, many industrial uses for non-fat dry

milk solids, also whey, will be developed from time to time. However, such industrial uses must compete with very cheap industrial products, such as cellulose, soybean protein, etc., and unless such products replace some expensive products heretofore used, the economics of such utilization may not be sound. The dry milk industry, in the years prior to World War II, has done very excellent work in introducing non-fat dry milk solids into many fields, notably the bakery industry. The production of non-fat dry milk solids (human grade) prior to the war was almost 300,000,000 pounds, and about 2/3 of this was utilized by the bakery industry. Non-fat dry milk solids have a number of advantages in baking, both in the manufacturing process, and in the characteristics in the resulting products. A very considerable improvement in the nutritive value of white bread by the addition of 6% non-fat dry milk solids, is not generally appreciated by either the baker or the consuming public. It is important that such knowledge be widely disseminated.

Confectionery, sausage, prepared mixes, and various other products have offered outlets for small amounts of the non-fat dry milk solids. But even so, such outlets would take care of only a small amount of the available production capacity that we now have in this country.

Let us now consider a few possibilities as to the utilization of the potential increased production of non-fat dry milk solids.

I.—Since this product is nutritionally one of the best foods that we have today, it seems highly desirable that it be included in many products on the market that do not at the present time have any appreciable quantities of dairy products in them. At the same time, it is desirable that the public be told through an educational program, the nutritional value of non-fat dry milk solids. Increased amounts might be used in any food that normally is consumed with milk or cream, such as breakfast foods, prepared desserts, various prepared mixes, and any food, in fact, that is compatible with milk itself.

II.—Increased uses of non-fat dry milk solids in confections, together with the development of new confections, may offer some future outlets. The confectionery industry is always using considerable quantities of milk, and the amount used depends to some extent on the availability and price.

III.—It may be desirable to increase the amount of non-fat dry milk solids in certain types of beverages which might possibly be flavored in different ways to make them palatable and acceptable. Such products surely would be valuable from a nutritional standpoint.

IV.—Non-fat dry milk solids have found some use in the preparation of cottage cheese.

V.—It is believed by some that through proper education and merchandising, a retail package of non-fat dry milk solids could be sold to the housewife. Such packages have been used in England during the war. It is very imperative for the success of such a venture that proper promotion be

given the product, especially as to various culinary uses. It seems logical to assume that large quantities could be consumed in the home that would result in baked goods, candy, vegetables, etc., of superior flavor and nutritional value.

VI.—It seems logical to assume that entirely new and different types of food products can be developed, utilizing non-fat dry milk solids as a major constituent. This should be a much easier task when non-fat dry milk solids are available in large quantities at a reasonable figure. Such foods could open up an entirely new outlet for non-fat dry milk solids and their potentialities would only be limited by their public acceptance, cost and availability to the consumer.

Naturally, the competition between different branches of the dairy industry has always been keen, and each branch of the industry has always feared that the introduction of a new form of milk would displace its particular product. It is of course to be regretted that an over-all inclusion of milk in the diet cannot govern the success of any particular venture. It will be interesting to note such trends in the post-war period.

WHEY

In considering the utilization of whey it should be pointed out that the 90 pounds of liquid whey that is produced in the manufacture of 10 pounds of cheese is another source of human food that has heretofore not been utilized to any great extent. With the adoption by various states of regulations and laws requiring the pasteurization of milk for cheesemaking, which in turn is likely to tend toward the development of larger factories for the manufacture of cheese, it seems logical to conclude that larger amounts of good pasteurized whey will be available. This naturally suggests that various possible uses for whey will be given more serious consideration in the future. Whey solids have found use in cheese foods and cheese spreads, in baked goods, soups and candies. Whey is used as a source of lactose and lactic acid. The use of lactose for the manufacture of penicillin has stimulated lactose production. The largest use of whey has been and still continues to be for animal feed. Whey has excellent food values and its further use in various food products offers distinct possibilities.

CONCLUSIONS

We have endeavored to look into the future and consider various developments that may take place in the dairy industry, and by way of conclusion we want to stress the necessity for extensive continued research in the utilization of milk.

Along with the development of new products and uses for milk in its various forms, there should be developed a very aggressive advertising and merchandising program of education as to the real value of the milk products.

SOME CHANGES THAT MAY INFLUENCE THE DAIRY PRODUCTION BUSINESS OF THE FUTURE*

S. J. BROWNELL, C. Y. CANNON, W. E. KRAUSS, H. W. NORTON, JR., C. W. TURNER, EARL WEAVER AND O. E. REED, *Chairman*

American Dairy Science Association Committee on Post-War Dairy Production

There will probably be tremendous developments in agriculture after the war which will involve changes not only in our general agricultural scheme but also in dairy farming. We have already overcropped much of our land and abused and neglected our natural resources of soil fertility. Now we must begin to cover "overdrawn checks" and build up a balance. These deposits will increasingly be in soil conservation measures such as erosion prevention and putting down more land to grass to hold and build soils.

When we increase our grasslands, what is the logical outcome? Farm animals make use of pasture, hay, and other grassland roughages. A dairy cow can handle a larger proportion of this type of feed in her daily ration than any other farm animal and she also can produce more potential human food from a given amount of digestible nutrients than any other farm animal. The increase in grasslands and the increase in dairy cows have already set the stage for an expanding dairy production. In the past 5 years our total dairy cow population has increased about 8.7 per cent, heifers between 1 and 2 years about 14.5 per cent, and heifers under 1 year about 21.7 per cent.

INFLUENCE OF EXPANDED PRODUCTION

But what of markets for the disposal of our potential milk supply? The war has stepped up production of milk to provide dairy products for our civilians, for the armed forces, and for feeding allied military and civilian personnel. This demand will not cease abruptly, but will likely continue until other countries can rehabilitate their dairy industries. They will not only have to rebuild their herds but they will have to produce roughages in large quantities, and shipping must be available to import large quantities of concentrates upon which they have always depended.

When this export demand is satisfied, however, we will have to depend on domestic markets almost entirely. We now have a nation of 140 million people—or approximately 10 per cent more potential milk consumers than we had a decade ago. By the standards of nutritionists, we could well increase our milk production several billion pounds annually to take care of the domestic need. If our people had full access to dairy products, the increase in consumption would be large at the present time. If butter, cheese, cream (including whipping cream), and ice cream were readily available, our people would buy much more than they are using at present.

* Report prepared for the 1945 meeting of the American Dairy Science Association which was cancelled because of war travel and housing conditions.

Of course, we are now working at a high level of national income and, while many signs point to a rather prolonged industrial activity to meet the unsatisfied demand for many types of consumers' goods, there may be some decrease in buyers' incomes. Also, competition in the food market from substitutes and synthetics will probably be keener than ever following this war. Therefore, dairymen may find it necessary to reduce production costs much lower than at present, in order that the price of milk and dairy products may be made more attractive to the consumer. Economy and efficiency of milk production will continue to be an important factor for dairymen to consider. This will call for more efficient cows—cows with greater capacity for using the home-grown roughages, longer lived cows to reduce cost of replacements, and cows capable of heavier production.

The keener competition in the food market will also require that closer attention be paid to sanitary methods of producing and processing milk in order to provide a product of superior quality that will appeal to the taste of a more discriminating public. This will call for the production of better and cleaner milk and cream on the farm, from which high-quality dairy products can be made. Dairymen will have to take better care of their cows and use improved facilities all around—a great change will be needed on many dairy farms. Dairymen will have to improve methods in all lines, in sanitation and disease control, in breeding better animals, and in better feeding to meet this threat of keener competition in the future.

SOME NEWER DEVELOPMENTS AND TRENDS

One of the recent developments in the milk production field is the discovery that rumen microorganisms can make protein from urea nitrogen and that urea can be fed to dairy cows as a partial replacement for high-protein feeds. This chemical product, the enlarged acreages of soybeans, and the improved practices in harvesting and preserving roughages will all help to furnish dairymen with much more available protein after the war than they have had before. This automatically will mean increased milk yields, which in turn will mean lower costs per pound of milk.

Calfhood vaccinations for Brucellosis will mean more length of life for milking cows and less loss to dairymen. Improved herd management practices, coupled with new treatments for mastitis will reduce mortality and thus increase the number of cows. Research now under way suggests that the use of drugs and vitamin supplements to protect calves in their early life may reduce calfhood mortality. This would mean more sound cows. These extra cows would give the farmer a much wider range of selection so that he could carry forward a breeding program for improving his cattle faster than heretofore.

In this connection there is apt to be another effect. If more calves are saved and carried by the farmer into his herd as a new generation because

of their improved genetic worth-whileness, then milking cows will be thrown on the beef market in large numbers. A greater percentage of the beef supply of this country may originate in dairy herds than has been the case in the immediate past.

More use of machinery, such as milking machines, manure loaders, forage harvesters, etc., will make it easier for farmers to keep larger dairy herds. The average number of dairy cows per herd will likely increase under these conditions. Of course, any labor-saving device helps to lower production costs.

The trend toward the shed-type barn in many parts of the country will permit expansion of herds without increasing labor and overhead costs proportionally. Shed-type barns also save labor since manure handling and other jobs are cut down.

The increase in production of soil-conserving crops and the greater use of this type of feed for dairy cattle emphasizes the importance of high quality in roughage. The conditions under which forage is harvested and preserved determines to a large extent its quality and feeding value. The best stage for harvesting various forage crops to produce the maximum feed value per acre is being determined. Improvements in methods of harvesting and storage and new ways of processing feeds that will reduce nutrient losses are being worked out. New machines that will do the job of harvesting and storing feeds with a minimum loss of nutrient content and that will greatly reduce the labor required and eliminate much of the drudgery and hard work of harvesting are being developed and will find widespread use in the post-war period.

The Government administrators are talking of 60 million jobs after the war. Many women who have a general farm background and are now in factory work may be available for such jobs as can be provided in dairy barns. The new machinery and barn designs are taking much of the drudgery out of dairy operations, thus making them better suited to the physical abilities of women. Dairying will expand rapidly under the impact of this trend and other factors which make laborers more readily available.

The increasing interest in the vitamin A content of dairy products, particularly butter, as exemplified by the Nation-wide survey made for the Food and Nutrition Board of the National Research Council during the last few years, may have an influence on winter-feeding practices. The lower vitamin A values of milk and butter during the winter months suggest the need for further studies on forage harvesting and storage techniques and for more widespread adoption of recommended practices that conserve carotene, namely, meadow-crop silage making and barn-curing of hay. Improved pasture practices would increase still further the vitamin A potency of summer butter.

As a result of the vitamin A survey, the investigators concluded that if,

by proper feeding, the vitamin A potency of winter milk could be increased to that of summer milk, that is, to 1,800 International Units per quart, dairy products on the 1941 basis of consumption would furnish nearly 40 per cent of the recommended daily allowance of vitamin A for a normal adult. It is quite possible that milk may eventually be sold, on some markets at least, at a premium based on its vitamin A potency.

The increasing emphasis on the nutritional value of nonfat-milk-solids and the trend during wartime for manufacturing plants to take whole milk is changing the complexion of the dairy industry throughout the Middle West. This change may make the Middle West a strong competitor of dairymen in the eastern area of the United States. Milk production on farms during the past decade (1934 through 1944) increased about 16 billion pounds. During the same period, deliveries of whole milk to plants, dealers, etc., rose 30 billion pounds, primarily because of the increase in the production of milk on the farms, but also because of the trend toward the manufacture of greater quantities of whole milk products. In recent years, the increased deliveries of whole milk were a reflection of the large requirements for cheese and the nonfat solids of milk for military and lend-lease use.

The upward trend in sales of whole milk products has been accompanied by a downward trend in sales of cream and farm butter. The decline in the volume of milk used on farms was partly the result of decreases in farm population.

DEVELOPMENTS IN DAIRY CATTLE BREEDING AND SELECTION

The breeding of dairy cattle has been going through a revolution during the past twenty-five years. We now find ourselves on the threshold of a new era, as we consider post-war developments. Methods for discovering and fixing desirable characteristics in strains of dairy cattle have been developed. More reliable methods for selecting dairy animals through a carefully developed analysis of environmental and genetic characters are in use.

Previous to 1920, the major emphasis in dairy cattle breeding was placed on milk production or somatic expression. In 1919 the Bureau of Dairy Industry started a breeding program which has shown the possibility of fixing desirable dairy characters through the selection and use of sires of desirable genetic expression. This research has brought about a gradual change in dairy cattle breeding methods and centered the attention of progressive dairymen on the use of progeny-tested sires. Today the idea of genetic expression, when measured with true interpretations of environmental influences, is the generally accepted and practical basis of dairy cattle breeding.

The establishment of proved-sire analyses in connection with the dairy-herd-improvement-association program throughout the United States in 1925 supplemented materially the educational program. The search for superior

germ plasm in 1935 increased the consciousness of dairy cattle breeders of the importance of genetic expression. This was supplemented the same year in New York State by the launching of a careful herd analysis, which gave weight to environmental influences as they affected genetic expression.

Greater interest in the use of bulls of known ability to transmit superior dairy characters grew out of these changes in dairy cattle breeding practices. The dairy-herd-improvement proved-sire program and breeding analysis will continue to help many dairymen find animals of outstanding inheritance.

Considerable interest is now developing concerning the possibility of improving milk yield in commercial herds by crossing the dairy breeds. Cross breeding is being practiced to some extent in the poultry, swine, and beef cattle industries, and from time to time dairy farmers have introduced bulls of another breed to mate with their cows. Such mixing of breeds in dairy herds has always been done without regard to any definite plan and little information of scientific value has been obtained. Cross breeding experiments are now under way which in time should indicate whether or not the increased milk yields that some dairymen have attributed to crossing breeds are the result of hybrid vigor. If these experiments show there is anything to be gained by crossing breeds, it will have an important effect on the milk production practices in commercial herds.

While it is impossible to place too much emphasis on the necessity of breeding and selecting for increased production, breeders will continue also to give attention to selection for type or conformation. Four of the five dairy breed registry associations already have type classification programs in effect and plans are being made by the fifth organization to adopt such a program. The Herd Classification program affords a demonstration for the purebred breeder and dairyman of the kind of animals to select and breed in order to improve the herd from the standpoint of breed type or conformation. At the same time it eliminates the "poor type" animals from the breeding program as their certificates of registry are canceled and it bars registration of bulls from "fair type" cows. Regular classification of the herd for type, combined with continuous testing of the entire herd for production year after year, should result in steady improvement in the type and producing quality of these seedstock herds.

Another method of selection, which may have an important bearing on future production methods, is the examination of the udders of young heifer calves to determine their relative producing ability at milking age. The method, which has proved successful in the experimental breeding herd where it was developed, is now being tested out in a number of other herds. If it proves to be practical and possible under ordinary farm conditions to select future high milk producers while they are still young calves, dairy farmers will be able to avoid the expense of raising large numbers of young heifers that turn out to be unprofitable cows.

ARTIFICIAL INSEMINATION

For some time prior to 1938, research work at Beltsville, Md., and at various State colleges and experiment stations was demonstrating the practicability of artificial insemination for dairy cattle. The insemination program has developed rapidly in the United States since that time. Several States are now inseminating 10 per cent of their dairy cows. Some have established service available in every county in the State. Today dairymen in hundreds of counties throughout the United States have the services of better bulls than were ever available to them before.

Very definite results are in evidence today indicating the possibilities of the future. Production results are available now in Maine, New Jersey, and New York. In each of these States the animals resulting from artificial insemination have on the average produced from 20 to 30 pounds more butterfat than their dams because of the superior quality of the bulls selected to "sire" them.

Certain genetic characters previously unseen have been brought to light by artificial insemination programs. Evidences of low fertility in certain strains have pointed the way to improving the fertility program in many herds. The old stumbling block in selecting superior dairy characters—that is, the inability to obtain a sufficiently large sample of offspring to be significant—has now been removed.

If the artificial insemination program continues to gain ground as rapidly as it has during the past few years, and results come up to expectations, it should be an important factor in improving the milk-producing efficiency of many herds. This will come about chiefly through large cooperatives made up principally of commercial herds. Through these cooperatives many dairymen will be able to breed their cows to a much better sire than they could afford to own individually. At the same time, many of these dairymen will purchase one or more foundation females to mate with these better sires and start building purebred herds.

Another important effect of the artificial insemination program will come from exchanging the service of especially valuable sires between purebred herds, mating the better brood cows in these herds with one of the top sires of the breed regardless of his location. This will be desirable from the standpoint of breed improvement and will result in very many effective matings which would be impossible through natural service. It is doubtful if any large percentage of breeders will be satisfied with service through the cooperatives as they are unable to follow a breeding program along definite lines, and particularly since most of the better breeders favor a line-breeding or close breeding program rather than an out-cross breeding program. It will be difficult to follow a line-breeding program in a cooperative until such time as the entire community can be sold on the adoption of such a program so that sires of certain blood lines may be selected and later replacements of

proper relationship be chosen to carry on in succeeding generations. This will undoubtedly become a part of the cooperative artificial breeding program of the future.

INFLUENCE OF SCIENTIFIC KNOWLEDGE

The basic sciences of nutrition, physiology, biochemistry, and genetics will contribute much during the post-war years to the problems centering around the dairy cow as an efficient transformer of plant products into milk. As we learn more about each step in the process of converting the grain and roughage which the cow eats into the milk which she secretes, we will be able to understand and appreciate the reasons for the great differences in the productive capacity of the nation's cow population.

It is only within the past few years that dairy nutritionists have begun to fully appreciate the true function of the rumen as a huge digester tank in which the micro-flora and micro-fauna present there convert or digest the cellulose or crude fiber of the roughage (which cannot be digested by the ferments of the true digestive system) into more readily available products. Nor have they fully appreciated the capacity of these same microorganisms in synthesizing ammonia, urea or other amide nitrogenous compounds into body protein of good biological value which the cow digests and utilizes.

Thus while dairymen have been providing their cows with roughage and grain mixtures, this feed is radically changed in the rumen so that upon its passage into the true stomach of the cow, some of the original protein (or urea) has been converted into bacterial and yeast protein, much of the crude fiber (cellulose) has been converted into simple carbohydrate compounds, and vitamins of the B complex have been synthesized by these organisms in large amounts.

This new knowledge of rumen function opens up an entirely new field of "dairy cattle feeding." If the rumen microorganisms play such a vital role in dairy cow nutrition it behooves us to learn more about their behavior. What are their growth requirements? How can we promote their most rapid growth? Are there differences in the quality of the protein of rumen organisms? Can the type of organisms be changed to improve the digestibility of the crude fiber (cellulose), the utilization of more urea or amide nitrogen, the amounts of the vitamins of the B complex which can be synthesized?

For this work the dairy cow nutritionists must call upon scientists trained in bacteria-fermentation and yeast-fermentation, upon workers trained in the micro-biological methods of vitamin assay, upon protozoologists (for the protozoa also grow in the rumen in large numbers), upon nutritionists trained in the determination of the quality of protein, etc. Such a group of investigators should be able to advance greatly not only the science of rumen nutrition but the art of dairy cattle feeding. They would have the

tools to center their attention upon one of the most unique adaptations of the digestive system in the animal kingdom, an adaptation which has made it possible for the dairy cow to become the most efficient converter of roughage (largely unavailable to non-ruminant animals) into the most nearly perfect food for man.

The second phase of dairy science research which may greatly influence the dairy industry of the future is concerned with the study of the products of digestion, *i.e.*, the constituents of the blood, and their mode of conversion by the cow's udder into the various constituents of milk. In this process the hormones of the endocrine glands play many vital roles. Not only do the hormones influence the rate of absorption of the nutrients from the digestive tract, but they control the rate of flow of nutrients from storage depots into and out from the blood, their use or metabolism in the tissues and the flow of blood to the cow's udder for the manufacture of milk.

The size of the cow's milk-manufacturing plant is one of the prime limiting factors in her capacity to secrete milk just as the size of a factory limits its production. Here again the hormones come into play because they alone stimulate the growth of the udder and limitations in the intensity or duration of the stimuli have been shown to limit the extent of udder growth.

However, just as two factories of the same size may differ widely in the amount of manufactured goods which they may turn out per year, so too there are differences in the milk secreting capacity of cows with udders of the same size. This is probably due to variations in the intensity in the rate of secretion. Again the hormones enter into the problem.

During the past 10 to 15 years, the students of milk-secretion physiology and endocrinology have discovered the basic plan of endocrine action insofar as it concerns the hormones stimulating the growth of the cow's udder, the stimulation of milk secretion, and the hormones regulating the removal of milk. The problem of the present and of the immediate future is concerned with methods of adapting this basic knowledge to the art of milk production.

One of the outstanding contributions of endocrine knowledge adapted to practice during the war years has been the program of rapid milking, in the promotion of which the nation's milking machine manufacturers deserve great credit. Not only has the program saved labor during this critical period but it has promoted the secretion of more milk and the maintenance of healthy udders. This program is worthy of extensive promotion until rapid milking becomes the standard practice of our dairy industry.

At the present time great loss is incurred by dairy farmers due to their inability to obtain conception in all of their cows at regular intervals. Cows should calve at yearly intervals for most efficient milk production. Since the process of reproduction is controlled by the action and interaction of the hormones and endocrine glands, further study may contribute to the regular reproduction of our cattle.

However, when cattle fail to breed, their value quickly degenerates to the carcass value. Many cows of exceptional potential milk manufacturing ability must now be discarded because we are not able to throw the milk secreting machinery into gear again. Knowledge gained during the past few years has shown us how to do the job, but practical methods have not yet been developed.

A promising development in this field is a chemical compound called diethylstilbestrol. This product, as well as other similar products, has many properties of the natural ovarian hormone called estrogen. It will stimulate partial growth of the cow's udder and further it will stimulate the secretion by the pituitary of the lactogenic hormone which in turn stimulates the cells of the cow's udder to secrete milk, but it apparently adversely affects the reproductive organs of the cow. Fair yields of milk have been obtained from sterile heifers and cows by treatment with this chemical compound. While it points the way to the development of mammary function in sterile cows by practical hormone therapy, studies should be made to determine the physiological factors limiting the utilization of synthetic estrogens and to avoid the bad effects that sometimes result from their use.

About ten years ago, the important role of the thyroid gland hormone, called thyroxine, in stimulating the intensity of milk and fat secretion was discovered. The feeding of thyroid gland or the injection of thyroxine caused a marked rise in milk yield and an increased fat content of the milk in cows in declining stages of the lactation cycle. However, the feeding of thyroid was too expensive to be practical and the injection of thyroxine would not be a feasible procedure.

As a substitute for these products, it has been discovered that iodine and casein or other proteins rich in the amino acid tyrosine, can be converted into a synthetic thyroprotein having the same physiological properties as desiccated thyroid or thyroxine. In fact, by the hydrolysis of thyroprotein, good yields of crystalline thyroxine have been recovered.

Thyroprotein can be formed containing twenty times or more the potency of U. S. P. Thyroid. It will be sufficiently economical to produce to warrant its inclusion in the ration of milking animals. When fed during the declining phase of the lactation period it should maintain milk secretion at a higher than normal level. It will not prevent the decline in milk secretion but it will decrease the rate of decline. Whether the feeding of thyroprotein for increased milk yield will be economical, and whether it can be fed over long periods without injury to the cow, are questions yet to be answered.

Since thyroprotein is one of the first hormone products which may eventually have practical application, its acceptance by the industry will be watched with interest.

It must be remembered that the fundamental objective of dairying should be to produce milk of the highest nutritive value at as low a cost as possible.

Milk is the basis of an adequate diet and everything must be done to improve its wholesomeness and nutritive value. This becomes increasingly important since rapid methods for determining nutritive value are becoming available and it is not at all impossible to visualize the term "quality" as including measurements of nutritive value when applied to milk of the future. Involved in this is the complete cycle of climate, soil, plants, animals, and man.

THE GAS REQUIREMENTS OF MOLDS. IV.[1] A PRELIMINARY INTERPRETATION OF THE GROWTH RATES OF FOUR COMMON MOLD CULTURES ON THE BASIS OF ABSORBED GASES[2]

N. S. GOLDING

Division of Dairy Husbandry, Agricultural Experiment Stations, State College of Washington, Pullman, Washington

INTRODUCTION

Previous work (7, 8), using several strains of *Penicillium roqueforti*, showed that in the absence of CO_2 these cultures exhibited marked tolerance to low O_2 tension. Only with the minimum O_2 (2 to 4 per cent O_2) did a significant reduction of growth occur, and this was more marked at the higher temperatures.

Low concentrations of CO_2 accelerated growth while larger concentrations were inhibitory (9). The accelerative and inhibitory concentrations of CO_2 were less at low than at high temperatures. This indicated that the respective absorption coefficients of O_2 and CO_2 might be of marked significance for the gas requirements of molds. However, considerably more data were required to suggest such a generalization.

To continue this study it was necessary to choose cultures of molds having uniform growth within a wide range of O_2 tension (4 to 21 per cent O_2) in the absence of CO_2. Further if the cultures of mold selected were able to grow equally as well in air over a reasonably wide range of pressure (*e.g.*, $\frac{1}{2}$, 1, and 2 atmospheres) the amount of absorbed gases could be greatly varied at the same growth temperature by changing the pressure under which the molds were grown. The different cultures of the same species used in the previous work (8, 9) varied to some extent in their tolerance to O_2 and CO_2. Therefore it was desirable that molds having a wide difference in their tolerance to CO_2 should be used in this study.

The extensive use of CO_2 for cold storage, packing and shipping of many perishable food products makes it most desirable to know whether it is the gas above the medium, that absorbed in the medium or mycelium, or a combination of both, which determines the rate and extent of the growth of molds. This part of the study of the gas requirement of molds deals with the absorption of gases at various temperatures and pressures as they affect the growth of molds.

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[2] American Dairy Association Research Grant and in cooperation with the Washington State Dairy Products Commission.

LITERATURE

The literature pertaining to the earlier work on the gas requirements of molds is given by Brown (3) and Golding (7). Later work which deals largely with the practical application of CO_2 to cold storage (1, 13, 14) has been complicated by the use of media composed of living cells, *e.g.*, pears, cherries and other fruits which are giving off considerable CO_2 (1, 5, 6). These studies undoubtedly have their local application to practice but do little to advance the basic principles of the problem.

Assuming Buchanan and Fulmer's (4) explanation for preservatives, and that CO_2 acts as such, increases in the concentration of CO_2 in the air will begin with a stimulating effect and with further concentration pass to a mycrostatic action and finally if sufficiently high concentrations are possible a lethal action ultimately will be reached. It is well known, however, that the apparent toxicity, or at least inhibiting power of a preservative usually is increased with an increase in temperature. This does not account for the results reported in the previous work (3, 7, 9) in which it was shown that CO_2 was more toxic at the lower temperatures than at the higher, unless it also can be shown that there was a greater concentration of CO_2 in the medium or mycelium at the lower temperatures of growth. The higher absorption coefficient of CO_2 in water at lower temperatures therefore might account for this greater mycrostatic action of CO_2 at the lower temperatures.

MATERIALS AND METHODS

Cultures. The cultures of mold selected for this study were: *Aspergillus niger* 14, *Penicillium expansum* 69, *Aspergillus flavus* d. and *Oospora lactis* m. They were chosen because of their wide difference in physical characteristics, and because they commonly cause food spoilage and have widely different optimum temperatures of growth. These organisms have been frequently isolated from dairy products (2, 11, 12). Purification of each culture was done by the usual poured-plate technique (8). Microscopic examination and cultural characters of each were made at the start and end of the study. In addition, all four cultures were checked.[3]

Organisms Grown at Atmospheric Pressure

The methods followed were identical with those described in previous publications (8, 9) and the results obtained are expressed as growth curves as in the previous studies. Due to the higher growth temperatures of *A. niger*, *A. flavus* and *O. lactis* it was necessary to complete the curves by making separate runs at temperatures above 92° F. In a few cases the high temperature end of the growth curve had to be completed to zero growth by extrapolation.

[3] Fischer, Dr. George W., Plant pathologist, U.S.D.A., The State College of Washington.

Medium. The same lot of dehydrated Difco malt agar was used as for the previous studies (8, 9).

Slants. The cultures of mold for inoculation of the plates were grown on malt agar slants at from 70° F. to 75° F. for 10 days.

Plates. The preparation and inoculation of the plates were identical with the previous studies (7, 8, 9).

Incubation temperatures. Standardized Weston metallic thermometers were used for obtaining the temperatures in the desiccators. The average temperature was obtained from a daily night and morning reading during each run.

Nitrogen. The N_2 was taken from the same cylinder as in the previous study (8).

Carbon dioxide. The CO_2 was from the same cylinder as in the previous study (9).

Gas chambers. The gas chambers were the same desiccators as in the previous studies (7, 8, 9). As there was no significant difference in mold growth between air and air with its CO_2 removed, the latter was used for the air curve (8).

Adding and changing gas. Details for the method used in the daily change of gas are given by Golding for air diluted with N_2 less CO_2 (8) and air diluted with CO_2 (9).

Growth period. After inoculation, which required less than one hour, the plates were inverted and put in their respective desiccators and incubated for a period of 7 days for cultures *P. expansum, A. flavus,* and *O. lactis* and for 6 days for *A. niger* due to its more rapid growth.

Expression of growth. Growth was expressed by growth curves as in the previous studies (8, 9).

Organisms Grown at Various Pressures

The following modifications were made when the organisms were grown at various pressures:

Medium. A fresh supply of Difco malt agar was obtained as the previous supply was exhausted. As the growth in air on this new lot of medium attained approximately the same growth as the old lot it cannot be considered to have produced a significant change.

Gas supply. The gas supply of the required composition was prepared under pressure in a gas cylinder. By a series of reducing valves and a suction line the gas was led through three chambers (two pressure cookers and a vacuum desiccator), so as to approximate pressures of ½, 1, and 2 atmospheres. The results are expressed in mm. Hg absolute. During each experiment the chambers were tested daily to see that they were gas-tight. When a gas mixture other than air was used, all the chambers were evacuated to approximately ½ atmosphere before the experiment was started to

prevent a lag in the gas coming to the required composition. As the organisms were maintained practically for the whole growth period under a similar gas supply, no lag such as occurred with daily changes of gas (7, 8, 9) was experienced. Naturally the lag would be more significant if the gases had to be absorbed before the growth of the molds were affected.

EXPERIMENTAL

Air Diluted with Nitrogen

The effect of the reduction of O_2 obtained by adding N_2 as diluent in the absence of CO_2 on the growth of molds *A. niger, P. expansum, A. flavus* and *O. lactis,* is shown in figures 1 to 4 respectively.

Figures 1 to 4 demonstrate that the different molds are not equally susceptible to low partial pressure of O_2. The growth of *A. niger* and *A. flavus* which have a high optimum temperature of growth are inhibited at low O_2 pressures more than either *O. lactis* or *P. expansum* which are about equal in this respect, in spite of the fact that *O. lactis* has an optimum temperature of growth 10° F. higher than *P. expansum.* Therefore, the difference in sensitivity of the various molds subjected to low O_2 pressure cannot be expressed entirely by the difference in solubility of O_2 in water at the various temperatures.

Figure 1 shows that growth of *A. niger,* a mold with a high optimum temperature of growth, was not significantly reduced until the O_2 supply had been reduced below 4.2 per cent with N_2. The reduction in growth took place sooner at the high temperatures than at the low.

Figure 2 shows the growth of *P. expansum,* a mold with a quite low optimum temperature of growth, was barely reduced in growth until the O_2 supply had been reduced to 2.1 per cent with N_2. The slight reduction in growth was not sufficient to indicate that a temperature relationship existed.

Figure 3 shows that the growth of *A. flavus,* a mold with a quite high optimum temperature of growth, was not significantly reduced until the O_2 supply had been reduced to below 4.2 per cent with N_2. The least reduction in growth took place at the optimum temperature.

Figure 4 shows *O. lactis* to have an optimum temperature of growth of approximately 82.5° F. which is in agreement with a previous study (10). This mold was not significantly inhibited until the O_2 supply had been reduced to below 4.2 per cent with N_2. At the lower temperatures, this reduction in growth was not significant at 2.1 per cent O_2.

Air Diluted with CO_2

The dilutions of air with CO_2 given in figures 5 to 8, have been used because they cover a range of O_2 concentration that gave normal growth when the air was diluted with N_2 (Figs. 1 to 4). Thus the growth-inhibiting

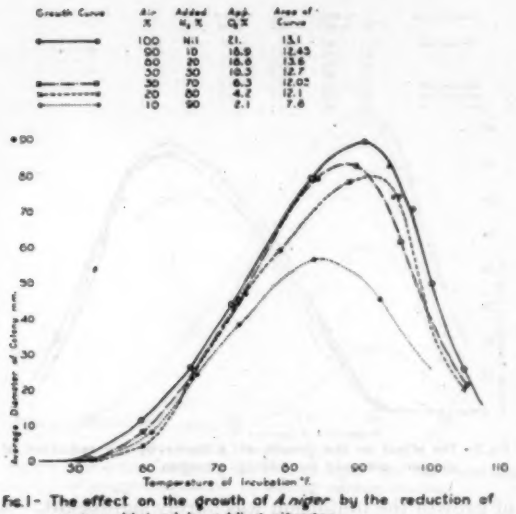

Fig. 1 - The effect on the growth of *A. niger* by the reduction of oxygen obtained by adding nitrogen.

effect shown in figures 5 to 8 can be attributed to CO_2 and not to shortage of O_2.

Figures 5 to 8 show the different mold cultures vary in their susceptibility to the inhibiting effect of CO_2. Even after corrections for the altered solubility of CO_2 in the medium, which will be discussed later, *O. lactis* remained the least affected by high concentrations of CO_2.

Figure 5 shows that the growth of *A. niger* in 10 per cent CO_2 was not noticeably reduced at the lower temperatures and even above the optimum

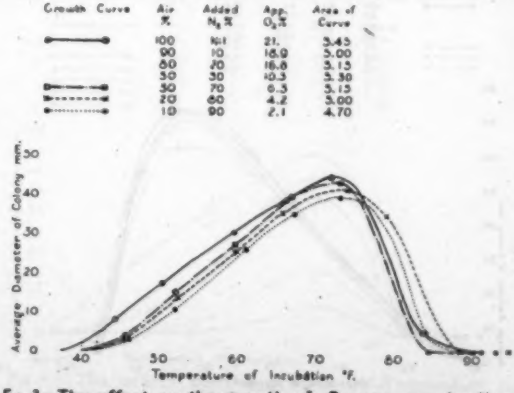

Fig. 2 - The effect on the growth of *P. expansum* by the reduction of oxygen obtained by adding nitrogen.

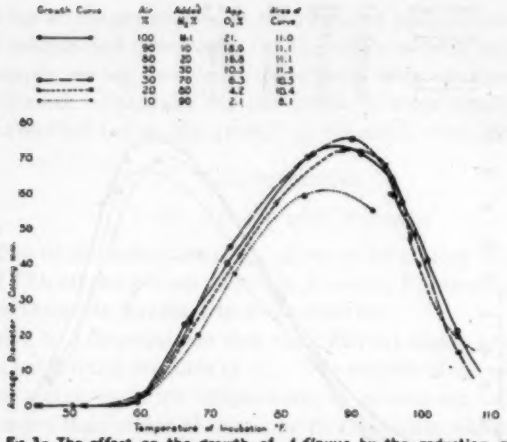

Fig. 3- The effect on the growth of *A. flavus* by the reduction of oxygen obtained by adding nitrogen.

temperature of growth the inhibition was barely significant. At 20 per cent CO_2 the reduction in growth at the low temperatures was definite; at the high temperatures it was hardly significant. At 50 per cent CO_2 there was no growth at temperatures below 69° F. and a considerable reduction at higher temperatures. At 70 per cent CO_2, there was no growth up to 75° F. and only slight growth at higher temperatures.

Figure 6 shows that the growth of *P. expansum* in 10 per cent CO_2, was considerably reduced except for temperatures well above the optimum where it was not significantly reduced. At 20 per cent CO_2, growth was inhibited

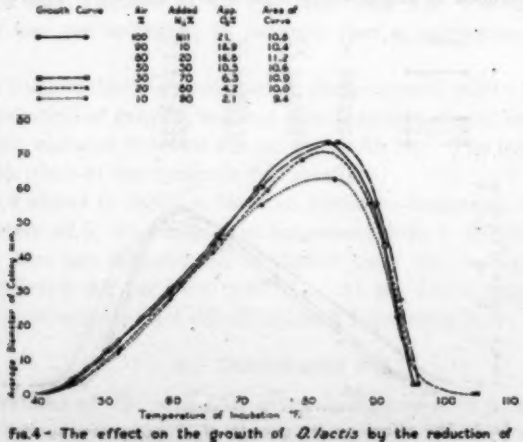

Fig. 4- The effect on the growth of *O. lactis* by the reduction of oxygen obtained by adding nitrogen.

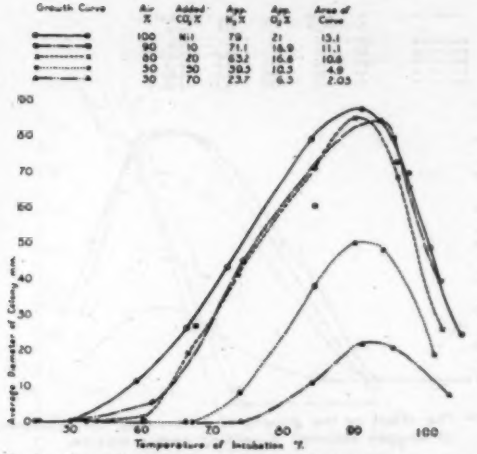

FIG. 5- The effect on the growth of *A. niger* by the reduction of oxygen obtained by adding carbon dioxide.

at all temperatures but showed a slightly greater inhibition at the lower temperatures. At 50 per cent CO_2, there was no growth below 53° F. and considerable reduction at higher temperatures. At 70 per cent CO_2, growth was entirely inhibited at the low temperatures, while only slight growth was noted at the higher temperatures.

Figure 7 shows that the growth of *A. flavus* at 10 per cent CO_2, was inhibited at the lower temperatures but not at the high. At 20 per cent CO_2, growth was inhibited at all temperatures but this inhibition was minimum at the high temperatures. At 50 per cent CO_2, there was no growth below 62° F. and the inhibiting effect of the CO_2 was less as the temperature

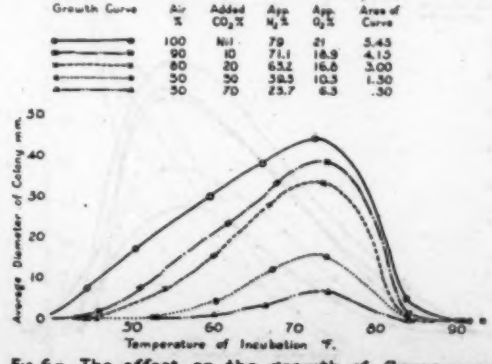

FIG. 6- The effect on the growth of *R. expansum* by the reduction of oxygen obtained by adding carbon dioxide.

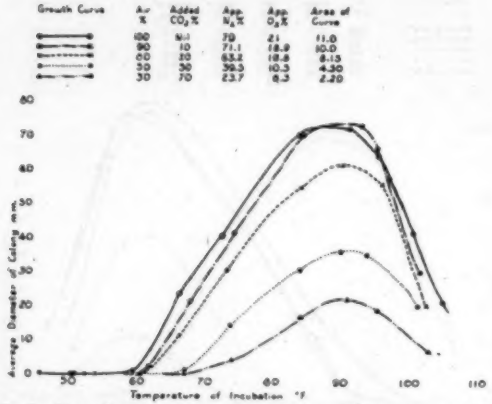

FIG. 7- The effect on the growth of *A. flavus* by the reduction of oxygen obtained by adding carbon dioxide.

was increased. At 70 per cent CO_2 there was no growth until 67° F. and the inhibiting effect of the CO_2 was less as the temperature increased.

Figure 8 shows that the growth of *O. lactis* at 10 per cent and 20 per cent CO_2, was slightly inhibited at the low temperatures but not effected at temperatures above the optimum. At 50 per cent CO_2, growth was inhibited more at the low temperatures while the growth at 70° F. and higher temperatures was uniform. At 70 per cent CO_2, growth was inhibited more at the low temperatures but less at the high.

When graphs were drawn from the data presented in the growth curves,

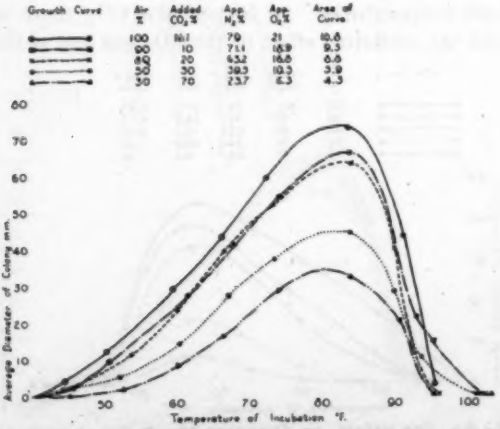

FIG. 8- The effect on the growth of *O. lactis* by the reduction of oxygen obtained by adding carbon dioxide.

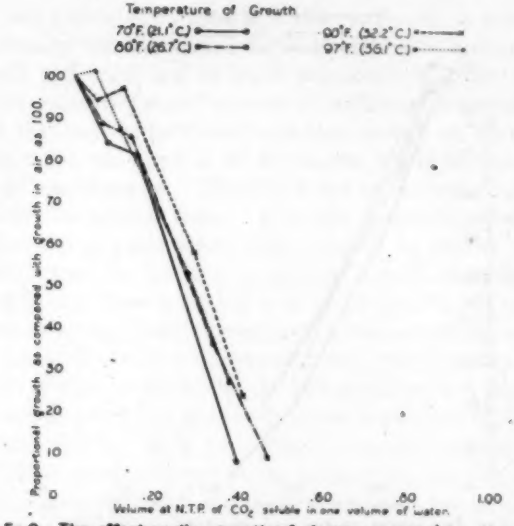

Fig. 9 - The effect on the growth of *A. niger* caused by the CO_2 soluble in water.

figures 1 to 4, (air diluted with N_2), using growth as the vertical axis and the percentage of O_2 in the air as the horizontal axis, it was found that for all four organisms, growth was not reduced until there was less than 6.3 per cent of O_2 in the air above the medium. From this point on, the reduction

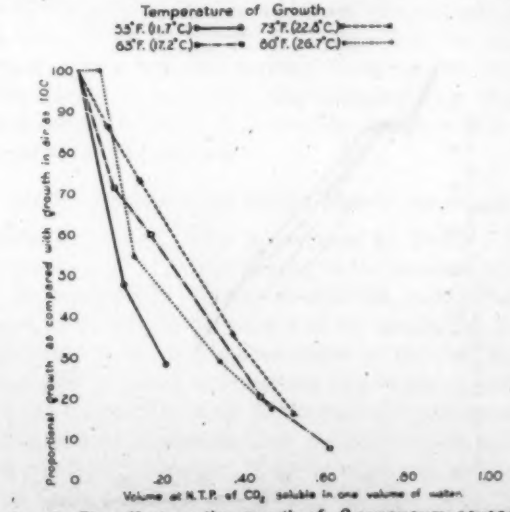

Fig. 10 - The effect on the growth of *P. expansum* caused by the CO_2 soluble in water.

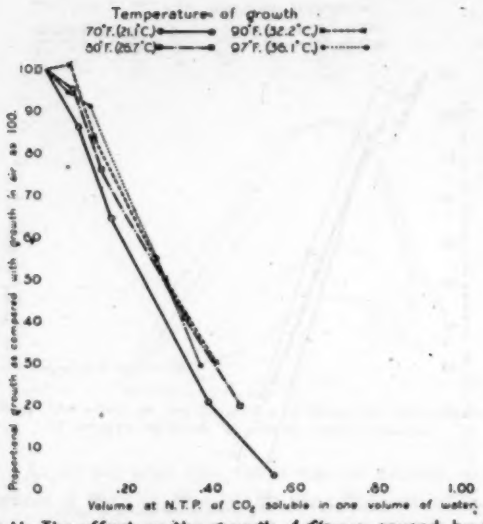

FIG. 11 – The effect on the growth *A. flavus* caused by the CO_2 soluble in water.

in growth at the optimum temperature of growth was greater with the organisms which have the higher optimum temperatures of growth. The order of greatest restriction in growth due to shortage of O_2 was *A. niger*, *A. flavus* and *O. lactis;* while it was doubtful if even at 2.1 per cent O_2,

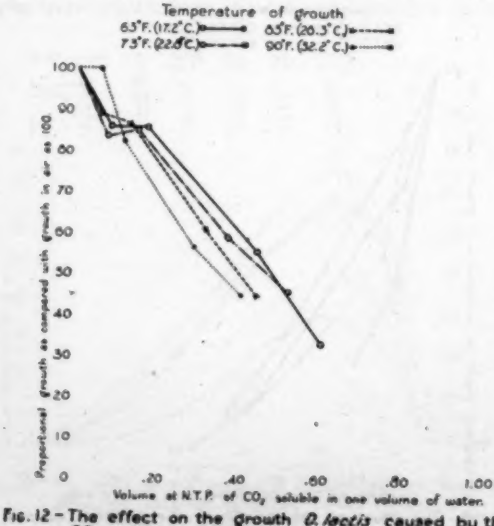

FIG. 12 – The effect on the growth *O. lactis* caused by the CO_2 soluble in water.

P. expansum was restricted in growth. The restriction in growth with all organisms definitely showed more inhibition above the optimum temperatures of growth and much less at lower temperatures. The variations in growth at different temperatures are not of sufficient magnitude to justify the conclusion that had the horizontal axis been plotted on the basis of solubility of O_2 in water, the slope of all the curves would be the same for all organisms at all temperatures. Thus far it can be concluded only that they appear to follow this general trend. However, greater dilutions of the air with N_2 will have to be made before this point can be proved.

The growth curves with air and air diluted with N_2 show definitely that the dilution of the O_2 down to 6.3 per cent by adding N_2 has not been sufficiently great to cause any restriction of growth due to shortage of O_2. When graphs were drawn for the growth curves, using growth as the vertical axis and percentage of CO_2 in the air as the horizontal axis, it was found that there was a marked restriction in growth as the percentage of CO_2 in the air increased, though the O_2 supply was sufficient to allow normal growth.

This restriction appears to operate as follows: 1. It is a function of the particular organism as *O. lactis* was found to be much less affected than the other three molds. 2. The restriction in growth is much greater at the low temperatures of growth.

If growth in air at any given temperature for a particular organism is considered as 100, then the growth in a definite gas mixture at the same temperature with the same organism will give the proportional growth for that gas mixture. Figuring the solubility of CO_2 in water for the given temperature and the partial pressure of CO_2 the proportional growth can be plotted against ml. of CO_2 at N.T.P. (0° C. and 760 mm. Hg) soluble in each ml. of water. Such was done for four temperatures with each of the organisms (Figs. 9, 10, 11, and 12). These figures show that the inhibiting effect of the soluble CO_2 was in general the function of a straight line, as the concentration of CO_2 increased.

GROWTH OF THE MOLDS UNDER VARIOUS PRESSURES

The solubility of a gas in water is governed by Henry's Law (*i.e.*, the solubility of a gas in a liquid is proportional to the pressure of the gas above the liquid). As it is possible that the soluble CO_2 rather than that which is in the gaseous state inhibits the growth of the molds, gas pressure might be used in this study to increase the solubility of the CO_2 in the medium. Such an opportunity to prove the previous hypothesis is provided only if the four molds grow normally in air at the required pressures.

Table 1 shows that all 4 cultures grew normally in air at 344, 702, and 1,400 mm. Hg absolute pressures. That is to say, in no case within the pressure ranges used was there a variation of more than 10 per cent in growth from that at atmospheric pressure.

TABLE 1

The growth of the 4 molds under various pressures in air
(Approximate average temperature 74.0° F.)

	Average pressure mm. Hg absolute		
	344	702	1400
	Average diameter of colonies in mm.		
A. niger—14	47.2	44.8	40.7
P. expansum—69	45.8	45.0	43.4
A. flavus—d	44.6	49.0	51.0
O. lactis—m	62.0	60.2	60.6

On the basis of the growth curves resulting from the different mixtures of air and N_2 at atmospheric pressure, normal growth would be expected at the pressure used in table 1 even assuming the absorbed gases were the important factor in the gas requirements of these organisms.

A mixture of gases approximating 20 per cent CO_2 and 80 per cent air was chosen in which to grow the 4 molds under similar pressures to that used in table 1. The molds grown in such a mixture at atmospheric pressure previously had produced on an average of about ¾ of normal growth. Table 2 shows the effect of such a mixture on the growth of the 4 molds at the 3 pressures. Growth was almost normal at the low pressure (323 mm. Hg absolute), about 75 per cent normal at atmospheric pressure (696 mm. Hg absolute), and approximately 50 per cent of normal at the high pressure (1394 mm. Hg absolute). The *O. lactis* culture, previously shown to be the least affected by the higher percentages of CO_2 in the gas at atmospheric pressure, was least affected by the CO_2 under the high pressure. That is to say, growth for the three pressures was on the order of that obtained with 9, 19, and 38 per cent CO_2 in the air at atmospheric pressure (700 mm. Hg). Owing to different methods having been used to obtain the required gas mixtures in the growth chambers, a closer comparison is not justified.

DISCUSSION

From the limited data presented it appears quite unjustified to figure

TABLE 2

The growth of the 4 molds under various pressures in an average gas mixture of air 81 per cent and CO_2 19 per cent
(Approximate average temperature 74.8° F.)

	Average pressure mm. Hg absolute		
	322	698	1394
	Average diameter of colonies in mm.		
A. niger—14	47.2	35.4	9.8
P. expansum—69	41.0	31.9	17.0
A. flavus—d	42.0	31.2	14.8
O. lactis—m	59.2	51.0	36.4

the gas requirements of molds on the basis of the composition of the gas above the medium. The whole subject must be investigated on the basis of the solubility of these gases in the medium or mycelium at least in so far as the inhibiting effect of CO_2. Workers who only express the composition of the gas above the medium in their publications on gas cold storage (1, 3, 14) can be followed only with confidence where an exactly similar condition of temperature and gas pressure can be duplicated. Whether or not the O_2 requirements of molds should be based on the solubility of O_2 in the medium or mycelium requires further study.

To determine whether or not the solubility of the gas should be on the basis of mold mycelium or medium will require extensive investigation.

SUMMARY AND CONCLUSIONS

With four common mold cultures, *A. niger*, *P. expansum*, *A. flavus* and *O. lactis*, grown on malt agar in various gas mixtures at different temperatures and pressures, it is shown that growth is affected according to the gas laws as they govern the solubility of the gases in the medium or mycelium.

The inhibiting effect of CO_2 on the growth of these molds is in proportion to its solubility and not in proportion to the composition of the gas above the medium or mycelium. This has been shown to apply by changing either the temperature or the pressure of the gas above the organism during growth. It would appear that the O_2 requirements of the molds might be affected in a similar way but this factor remains to be proved.

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THE PHOSPHATASE TEST AND ITS APPLICATION TO CHEESE

LINCOLN M. LAMPERT

Dairy Service Laboratory, Department of Agriculture, Sacramento, California

The use of the phosphatase test to detect improperly pasteurized milk is now an accepted procedure (1). Quantitative data are available for the phosphatase activity of raw and heat-treated milk, but, in general, other dairy products have not been examined in a similar manner (4).

In this laboratory the Kay-Graham-Neave technic (1, p. 262), is used for the examination of milk. In California, under present law, milk may be pasteurized at 140° F. for 30 minutes and so the generally accepted phosphatase data for 143° F. pasteurization is not applicable. After September 15, 1945, the minimum temperature for pasteurization will be 143° F. It was found that the results of the Kay-Graham-Neave test after a 20-hour incubation period could be interpreted in terms of time and temperature of the heat-treatment given the milk. When the phenol-equivalents of the color developed with the Folin-Ciocalteu reagent are plotted against colorimeter or "Luximeter" readings on semi-log paper a straight line is obtained (6). Its slope is such that relatively high concentrations of phenol can be readily measured. If a similar line is drawn from the readings obtained from the Sharer Laboratory test (1, p. 272), its slope is very steep, making it difficult to measure directly similar concentrations of phenol.

Recently there was need here for an accurate test to detect cheese made from improperly pasteurized milk. This was brought about by an investigation following an epidemic of typhoid fever reportedly spread by the use of cheese made from raw milk (3). All cheese now sold in California to the retail trade must be made from pasteurized milk, cream or skim milk, except cheese aged for not less than sixty days from date of manufacture. Other states and cities have adopted similar laws.

Preliminary work indicated that the phosphatase test could be used on cheese. That this is practical has been shown by Sharer (7) and more recently by Caulfield and Martin (5). Owing to the presence of substances in cheese which interfere with the reagent, the Folin-Ciocalteu reagent cannot be used and accordingly a test based upon Sharer's procedure for milk was used. Sharer (7) stated that phosphatase could be detected in raw milk cheese 18 months old. Caulfield and Martin could detect phosphatase in experimental cheese made from 1 liter of milk pasteurized at 143° F. for 30 minutes and to which 0.25 per cent of raw milk was then added.

Caulfield and Martin used the New York City (Sharer) field test in their investigation and after a 30-minute incubation period expressed their findings in terms of negative or positive results. They did not give any

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quantitative data in terms of the amount of phenol liberated by the various lots of cheese examined.

EXPERIMENTAL

Through the cooperation of the Dairy Industry Division of the University of California at Davis ten lots of Cheddar cheese were made, using 75 gallons of milk in each case. The treatment given the milk is shown in table 1. The high-temperature–short-time pasteurization was done with a York unit. The milk treated by the holding method was pasteurized in a jacketed cheese vat. Each separate lot of milk was received, heat-treated and made into three pound cheeses on the same day, the entire work taking ten days.

TABLE 1

Heat treatment given milk used to manufacture cheese

Vat 1	Milk heated from 160° F. up to 165° F. over a period of 15 seconds. 10% by volume of raw milk added to cheese vat.
Vat 2	Milk heated from 160° F. up to 165° F. over a period of 15 seconds. 5% by volume of raw milk added to the cheese vat.
Vat 3	Milk heated at 143° F. for 30 minutes.
Vat 4	Raw milk.
Vat 5	Milk heated at 160° F. for 15 seconds.
Vat 6	Milk heated from 157° F. up to 163° F. over a period of 15 seconds.
Vat 7	Milk heated to 170° F. for 15 seconds.
Vat 8	Milk heated to 155° F. for 15 seconds.
Vat 9	Milk heated at 138° F. for 10 minutes and 143° F. for 20 minutes.
Vat 10	Milk heated at 143° F. for 30 minutes. 0.5% raw milk added to the cheese vat.

Vats 1, 2 and 10 represent pasteurized milk mixed with raw milk. Vats 5 and 7 represent high-temperature–short-time pasteurized milk and Vat 3 milk pasteurized by the holding method. Vats 6, 8, and 9 represent milk improperly pasteurized since some or all of it was not held at the proper temperature for the required time.

Phosphatase tests were made on each lot of raw milk, the heat-treated milk, the starter, the mixture of milk, starter and rennet in the vat and the whey and fresh curd. In every case negative results were obtained with the starter and the tests on the heat-treated milk and the mixture in the cheese vat, the whey and the fresh curd corresponded to the heat treatment given the milk. In other words, positive tests were obtained only when the cheese milk was underheated or when raw milk was present.

Inasmuch as our results were to be used for control purposes, the Sharer field test was not considered sufficiently useful for application to cheese. Furthermore, since many tests might be required, a procedure was sought which would eliminate various reagents, such as lead acetate and sodium pyrophosphate, used in the Sharer laboratory test. By this elimination, the use of much additional glassware such as pipettes, test tubes and beakers also was avoided. Since our experience had demonstrated the usefulness of a twenty-hour incubation time for milk, a similar period was used for

the cheese experiments. This time interval is convenient, since further liberation of phenol occurs but slowly after 18 hours of incubation. Samples can be prepared at almost any time in one day, incubated over night and examined the next day. This permits other work to be done in the meantime.

The following procedure was used in making the phosphatase tests on cheese: Place 5 grams of a representative sample of the cheese (weighed on a torsion balance) into a small mortar and macerate with 25 ml. of distilled water, added in small portions at a time. Filter the aqueous suspension, using a rapid filter paper, such as a #4 Whatman. The filtrate usually is clear although at times some turbidity may be present. One ml. of this filtrate is added to 10 ml. of Sharer's borate-buffer substrate. Any turbidity that may be present usually disappears during incubation. After incubation for 20 hours, add directly 0.1 ml. of a 0.5 per cent solution of copper sulfate (2), mix and then add 0.1 ml. of a 0.4 per cent alcoholic solution of 2,6-dibromoquinonechloroimide (B.Q.C. solution or Gibbs' reagent). Measure the depth of color after standing 15 minutes.

All reagents used were prepared from the pure chemicals. Copper sulfate hastens color development and also favors the formation of a more brilliant color. Comparable readings are obtained without the use of copper sulfate, but it appears advantageous to use it. Phenol standards were prepared according to the method of the American Public Health Association (2, p. 247). A one-hour incubation period probably can be used, but sufficient data have not yet been obtained upon which to base phenol color standards for such a procedure. At times a pink or purple tint developed in tests made on pasteurized cheese, probably on account of the excess of Gibbs' reagent present. Since no appreciable blue color was formed, there was no difficulty in interpretation.

Practically all of the fat in the cheese separates from the sample during maceration. The filtrate contains little fat, the amount not exceeding 0.1 per cent, as determined by the ether-extraction method. The type of filter paper used apparently has little influence upon the test, since practically the same results were obtained with solutions passed through a #4 Whatman paper and through a #42 Whatman paper which is very retentive. If the cheese suspension is centrifuged in order to clarify it, a decided decrease in phosphatase activity results. As shown in table 2, a determination of the pH values of filtered cheese suspensions so far encountered indicates their acidity has no detrimental effect upon the buffer solution. If a very acid cheese is encountered it would be necessary to prepare the suspension with a buffered solution. A drop of the cheese and buffer solution may be tested with thymol-blue indicator or a strip of pH indicator paper may be used to detect any solution which might be too acid in reaction, say below pH 9.2. Determinations of pH were made with a Beckman glass electrode instrument.

TABLE 2

pH of cheese filtrate and of buffer mixture

Cheese	pH of filtrate	1 ml. filtrate in 10 ml. buffer substrate
Cheddar	5.10	9.35
Cheddar*	5.70	9.30
Cottage	4.40	9.50
Monterey	5.20	9.35
"	5.50	9.45
Teleme	5.20	9.35
"	5.35	9.40

* The pH of this cheese in buffer solution prepared according to Sharer (7) was 8.8.

The presence of considerable cheese solids, as occurs in the ordinary Sharer procedure, may at times have a detrimental effect upon the buffer substrate or the enzyme activity. In some tests made here, the cheese was ground in buffer substrate without the addition of water. A decrease in phosphatase activity occurred when 1 ml. of such a suspension was used for the test.

Phosphatase tests also were made on cheese suspensions before they were filtered. One ml. of the suspension was added to 10 ml. of buffer substrate, incubated 20 hours and then treated according to Sharer's method, using lead acetate for clarification. As might be expected, the phosphatase activity was greater; usually 2 or 3 times the color intensity was obtained. Inasmuch as dependable and replicable results were obtained from the solutions prepared from the cheese filtrate, no extended work was done using cheese

TABLE 3

Variation in phosphatase activity
(micrograms phenol)*

Sample	Cheese suspension (†)	Filtrate (‡)
a	90	60
b	60	50
c	25	18
d	100	80
e	14	10
f	80	60
g	80	50
h	95	55
i	8	6
j	22	8

* Except for the values given in Column 2 the phenol values used throughout this paper represent the amount of phenol found in the solution prepared by adding 1 ml. of the filtered cheese suspension to 10 ml. of borate buffer and incubated for 20 hours. (One microgram = 0.001 mg.)

† 5 gm. of cheese macerated with 25 ml. of water, 1 ml. of suspension added to 10 ml. of buffer substrate; incubated 20 hours. Clarified with 0.1 ml. lead acetate solution and color developed in 5 ml. of filtrate. Total volume used for color development 5.1 ml.

‡ 1 ml. of filtrate from above cheese suspension added to 10 ml. of buffer substrate; incubated 20 hours. 0.1 ml. copper sulfate solution added and color developed. Total volume about 11.2 ml.

suspensions. The variations that may be found between the results on the cheese suspension and the filtrate obtained from it are shown in table 3.

One three-pound cheese made from each lot of milk described in table 1, was selected for testing purposes. The cheeses were stored in a cold room. Over a period of nearly 6 months, occasionally a plug from each cheese was removed and sent to the laboratory for a phosphatase test. The same cheese was plugged for samples throughout the experiment. A new cheese was plugged for tests run for the last set of experiments.

The tests were read with a "Luximeter." Some readings were made with a Klett-Sommerson photocolorimeter, but this instrument was not available much of the time and only "Luximeter" readings are reported here. Phenol solutions of known strength were used to calibrate the readings in terms of phenol equivalents. The results are shown in table 4.

TABLE 4

*Phenol equivalents (micrograms phenol) from phosphatase tests on cheddar cheese**

Age of cheese	Vat 1	Vat 2	Vat 3	Vat 4	Vat 5	Vat 6	Vat 7	Vat 8	Vat 9	Vat 10
days										
17	55	45	20	70	15	55	<10	45	50	50
25	45	.....	.....	.....	.....	65	.....	.....	.....	.....
39	65	.....	.....	65	25	.....	<10	65	45	55
40	.....	35	15	65	.....	55	<10	45	50	30
66	55	35	15	65	10	45	<10	45	15	30
101	70	55	25	65	10	50	<10	70	12	50
117	55	50	18	70	18	50	10	55	20	50
153	65	45	25	65	18	70	.....	55	55	45
166†	70	55	18	85	.....	65	10	.....	55	.....

* See Table 1 for heat treatment given milk.
† A new cheese was plugged for each of these samples.

With the exception of three tests made on cheese from Vat 9, after it was aged 66, 101 and 117 days, all the phosphatase tests on the cheeses accurately reflected the heat treatment given the milk. No explanation could be found for the change in the three tests mentioned. Owing to the small sample, insufficient amount was available to repeat these tests. Caulfield and Martin (5) found the phosphatase activity to diminish or become extinct in several cheese samples used in their study. This cannot be the case in the present instance since subsequent tests on the same cheese gave normal results. Caulfield and Martin noted a tendency for phosphatase activity to diminish in time. In the present work this was not found to be pronounced, and in general some increase in activity is indicated by the phenol values obtained on cheese made from improperly pasteurized milk.

When the testing procedure outlined above is used it appears advisable to accept a phenol value in excess of 0.035 mg. (35 micrograms) as an indication of improper pasteurization. Cheese made from milk pasteurized for

at least 15 seconds at 165° F. or over will give a phenol value of considerably less than 35 micrograms.

A control test using reagents only was run with every phosphatase test. Another control was made by immersing 1 ml. of the cheese suspension in a boiling water bath for about twenty seconds, and making a phosphatase test on this sample. In every test the reagent controls and the heat-treated samples gave negative results. Freshly prepared reagents should be used for phosphatase tests. A lot of Gibbs' reagent held in a refrigerator for ten days yielded a deeper color with phenol solution than was obtained with a freshly prepared reagent.

The work reported here was carried out on cheese manufactured under controlled conditions. Several samples of different types of commercially made cheese were obtained on which the history of the milk treatment was given. In each case the cheese was not over one month old. The phosphatase tests on these samples are reported in table 5.

TABLE 5

Phosphatase tests on commercial cheese

Sample	Type of cheese	Reported heat treatment	Phosphatase test (micrograms phenol	Interpretation
1214	Teleme	Flash 170° F. 16 seconds	10	Pasteurized
1215	Monterey	" " "	< 10	"
1275	"	165–175° F. " "	40	Improperly heat treated
1276	"	" " "	48	" " "
1277	Feta	?	50	" " "
8345	Romano	?	20	Pasteurized
924	Creamed cottage	?	< 10	"

An important finding made during this investigation is that a very definite increase in phosphatase activity occurs if mold is present in the sample tested. Mold particles isolated from cheese contained an active phosphatase and care must be taken to work with mold-free samples. When a very moldy cheese, made from pasteurized milk, was prepared by carefully cutting away all of the moldy surface, a reliable phosphatase test was obtained. Apparently no penetration of the enzyme into the body of the cheese occurred.

SUMMARY AND CONCLUSIONS

1. A procedure for making a phosphatase test on cheese is given.

2. The phosphatase test may be used on Cheddar, Monterey, Teleme, Feta, Romano and Cottage Cheese, and probably other similar varieties.

3. No cheese made from pasteurized milk was found to yield as much as 35 micrograms of phenol in the phosphatase test described.

4. Cheese made from pasteurized milk containing 0.5 per cent of raw milk may be readily detected.

5. Cheese made from milk heated to below pasteurization temperature or for too short a time may be detected.

6. Mold-free samples of cheese must be used.

7. No significant change in phosphatase activity occurred over a period of six months.

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UTILIZATION AND EXCRETION OF INGESTED ASCORBIC ACID BY THE DAIRY COW[1]

M. G. VAVICH, R. A. DUTCHER AND N. B. GUERRANT
Department of Agricultural and Biological Chemistry
AND S. I. BECHDEL
Department of Dairy Husbandry, The Pennsylvania State College, State College, Pennsylvania

INTRODUCTION

The influence of the diet of the dairy cow on the anti-scorbutic potency of the milk produced has occupied the interest of research workers in human nutrition and in dairy production since 1920 (6, 9, 10). The development of rapid chemical methods for the determination of ascorbic acid, notably the use of Tillman's reagent, sodium 2,6-dichlorobenzenoneindophenol, helped to substantiate the early findings of Hughes and co-workers (13) who found that the antiscorbutic potency of the milk produced was independent of the diet of the cow (12, 17, 21, 26). The amount of ascorbic acid in the milk has been reported to be influenced by breed and stage of lactation (11, 20, 28) and also by the season of the year (8, 11, 23) although the importance of the latter factor has been discounted by Kon (18).

The probable synthesis of ascorbic acid by the dairy cow has been suggested (12, 17, 18, 21, 22, 24, 25, 26) although no evidence is at hand to show where the synthesis takes place. Wendt (27) has claimed that ascorbic acid in cows' milk is synthesized by the udder parenchyma and that the amount of synthesis depends to some degree upon the condition of this organ.

Knight *et al.* (17) found that massive doses of ascorbic acid fed orally had no appreciable effect on the amount of ascorbic acid in the milk or blood plasma and only a slight effect on the amount of ascorbic acid excreted in the urine. Their findings relative to the rapid destruction of ascorbic acid in the rumen show this organ to be the original site of the loss of ingested ascorbic acid. However, Kendall and Chinn (15), working with rumen contents obtained from freshly slaughtered cattle, were unable to show decomposition of ascorbic acid in filtered rumen "liquid" *in vitro*.

While the available data do not point to a specific organ of synthesis they do substantiate the view that synthesis of ascorbic acid occurs in the bovine body. Most of the dietary experiments which bear on this subject have been of comparatively short duration. In the present investigation an attempt has been made to throw further light on the question. A Holstein cow was

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maintained on a low ascorbic acid ration for 15 months. During this period ascorbic acid determinations were made on the milk, the blood and the urine in order to follow changes in the ascorbic acid economy. Further studies were conducted to determine some of the factors affecting ascorbic acid destruction in the rumen.

EXPERIMENTAL

Methods and Apparatus

Ration. A representative four-year-old Holstein cow in the second month of her second lactation was selected as the experimental subject. During a period of one month this cow was continued on the herd ration while preliminary observations were made on the ascorbic acid content of the milk, the blood and the urine. Thereafter, an experimental diet of the following composition was fed:

	Per cent	*Per cent protein*
Casein	5.0	4.5
Dry yeast[2]	4.0	2.0
Hominy feed	65.5	7.2
Cornstarch	13.5	.....
Corn gluten meal	10.0	4.3
Salt mixture	2.0	.....
	100.0	18.0

One pound of this feed mixture was fed for every 3½ pounds of milk produced, but the daily ration was never reduced below 10 pounds. The daily ration was mixed with five pounds of dried beet pulp and divided into three portions which were fed at 6 A.M., 1 P.M. and 9 P.M., respectively. It was found necessary to supplement the basal ration daily with three pounds of oat straw or heat-treated low grade timothy hay as a further source of roughage. At weekly intervals, 10 ml. of shark liver oil (25,000 I.U. per g.) were fed as a source of vitamin A.

Blood Plasma. Blood was drawn from the jugular vein into an oxalated tube containing sufficient paraffin oil to protect the surface of the blood from contact with air. The tube was cooled immediately and protected from light. Plasma was separated by centrifuging in an angle centrifuge. Blood-plasma ascorbic acid was determined as follows: Five ml. of plasma and 10 ml. of 10 per cent metaphosphoric acid were pipetted into a centrifuge tube containing 5 ml. of distilled water. The tube was centrifuged in order to facilitate a sharper separation of the precipitated proteins, and aliquots of the supernatant metaphosphoric acid extract were taken for ascorbic acid determinations. An Evelyn photoelectric colorimeter was used with the

[2] 25% of the yeast was high potency vitamin D yeast (Fleischmann's type, 7–F, 3,200,000 U.S.P. units per pound).

buffered dye solution suggested by Mindlin and Butler (19) and corrections for turbidity and color were made according to Bessey (2).

Milk. Milk was collected in an ice-cooled brown bottle containing carbon dioxide. The apparatus, described by Knight *et al.* (16), consisted of a brown bottle fitted with a three-holed rubber stopper. In this stopper were placed; 1) a glass adapter with rubber tubing to fit over the teat, 2) a Bunsen valve to allow carbon dioxide, which was displaced by the incoming milk, to escape, and 3) a clamped rubber tube which would admit a 10-ml. pipette for the removal of aliquots of the milk sample. An aliquot of milk was pipetted into an equal volume of 10 per cent metaphosphoric acid solution. After shaking to break up aggregates of precipitated protein the mixture was titrated directly with indophenol dye solution to a pink end-point which persisted for 30 seconds.

Urine. The 24-hours urine sample was collected in a large carboy containing sufficient acetic acid to give a final concentration of about 5 per cent acetic acid. The urinal employed in the collection of urine and the method of collection have been described by Knight *et al.* (17). Three or four times during the collection, carbon dioxide gas was employed to flush air from the collection bottle. About 500 ml. of the collected urine were withdrawn under carbon dioxide pressure into an ice-cooled brown bottle containing carbon dioxide gas. Aliquots of the urine-acetic acid solution were analyzed for ascorbic acid, usually within an hour after obtaining the sample. A 5-ml. aliquot of the urine-acetic acid solution was pipetted into a colorimeter tube placed in the Evelyn photoelectric colorimeter and 5 ml. of buffered dye solution were added in three seconds. Galvanometer readings were taken at 5-second intervals for 30 seconds and these values were extrapolated to determine the zero-second reading.

Rumen Liquid. Two months after parturition a rumen fistula operation was performed as described by Bechdel *et al.* (1). Samples of rumen contents were obtained through the rumen fistula with the aid of a special long-handled dipper. *In vivo* samples were filtered through cheesecloth into a measured amount of 10 per cent metaphosphoric acid. Samples for *in vitro* studies were kept warm and immediately transferred to the *in vitro* apparatus which will be described later. Ascorbic acid in the rumen liquid was determined photoelectrically by a variation of the colorimetric method in which the unreacted dye was extracted with zylene as suggested by Bukatsch (4). The validity of the method depends on the assumption that the ascorbic acid reacts instantaneously with the dye and that the unreacted dye in the acid form is quantitatively removed by xylene from the aqueous acid phase. Once the residual dye is in solution in the xylene it is stable for several hours, thereby eliminating the necessity of taking readings immediately.

The procedure employed was as follows: 5 ml. of the unknown solution, containing 0–100 micrograms ascorbic acid in 5 per cent metaphosphoric

acid solution, were added to 12 ml. of a 2 mg. per cent dye solution, buffered to pH 6.8 according to Mindlin and Butler (19), in a 50-ml. centrifuge tube. To this were added immediately 20 ml. of xylene. The tube was stoppered and shaken vigorously for 15 seconds to remove the unreacted dye from the aqueous layer into the xylene. The tube was centrifuged and at least 10 ml. of the xylene were decanted into a colorimeter tube and read in the Evelyn photoelectric colorimeter which had been set at 100 with xylene in a matched tube. The photometric density L_s of the unknown solution was taken from the chart of $G - L$ values[3] and the L_b of a blank tube was likewise found. The difference $L_b - L_s$ is a measure of the photometric density L of the sample which may be calculated from the formula (19):

$$C = K (\log G_s - \log G_b) \text{ or } C = K (L_b - L_s)$$

The value of K was determined using known quantities of ascorbic acid, ranging in concentration from 0–100 micrograms per 5 ml. of five per cent metaphosphoric acid solution. It was found by plotting the galvanometer readings against concentration on semi-logarithmic paper that the relationship was represented by a straight line.

RESULTS

Blood Plasma. Blood plasma ascorbic acid determinations by the method described above gave values ranging from 0.28 to 0.59 mg. per 100 ml. plasma. This is well within the range of values reported by Bortree *et al.* (3). They reported a range of 0.11 to 0.80 mg. per 100 ml. blood plasma for 24 normal cows.

Milk. Results observed during the study of changes in milk production and ascorbic acid secretion in the milk, during most of one lactation period, are presented in graphical form in figure 1. The gradual decrease in the excretion of ascorbic acid in the milk paralleled the decline in milk production. The course of the ascorbic acid decline appeared to bear no relationship to the ascorbic acid intake.

Urine. The urinary ascorbic acid excretion was generally unpredictable except that the ingestion of large amounts of ascorbic acid appeared to increase the rate of excretion temporarily. Over a four-month period the urinary excretion averaged 57 mg. of ascorbic acid daily while the cow was subsisting on the low ascorbic acid ration.

In figure 2 the average hourly excretions of urinary ascorbic acid during the daytime and at night are compared. Except in one instance, the 184th night, the daytime hourly excretion was distinctly higher than the corresponding night excretion in terms of milligrams ascorbic acid excreted per hour. It should be noted that a large amount of ascorbic acid was fed during the 183rd day and apparently was carried over into the night collection.

Rumen Studies with Crystalline Ascorbic Acid. In figure 3 the rate of

[3] G is the galvanometer reading and $L = 2 - \log G$.

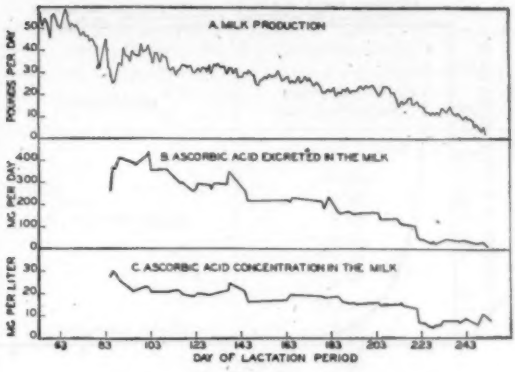
A. MILK PRODUCTION
POUNDS PER DAY
B. ASCORBIC ACID EXCRETED IN THE MILK
MG. PER DAY
C. ASCORBIC ACID CONCENTRATION IN THE MILK
MG. PER LITER
DAY OF LACTATION PERIOD

FIG. 1

destruction of ascorbic acid in the rumen "liquid" is shown after the ingestion of 150 grams of crystalline ascorbic acid in combination with corn silage. These data are in agreement with those of Knight (17). *In vitro* studies showed a similar rate of destruction.

Rumen Studies with "Cerograss Chops." The stability of ascorbic acid supplied as "Cerograss Chops" (dehydrated cereal grasses) is shown in figure 4. In both the *in vivo* and *in vitro* studies the initial concentration of ascorbic acid increased continually until about the third hour when the rate of destruction of ascorbic acid appeared to exceed the rate of solution of ascorbic acid from the grasses. The *in vivo* destruction also appeared to proceed at a faster rate. The retardation of the destruction of ascorbic acid in the *in vitro* study may be explained on the basis of the pH of the medium. It appeared that the lowered pH *in vitro* was less conducive to growth of the microorganisms owing perhaps to the accumulation of products of metabolism (Table 1).

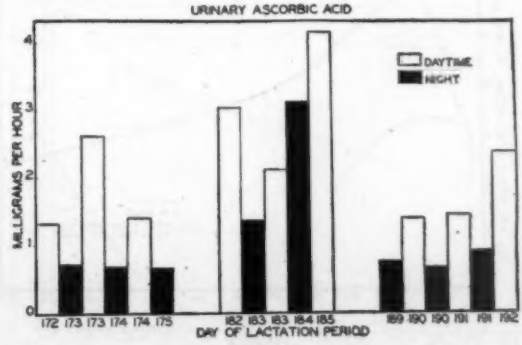

FIG. 2

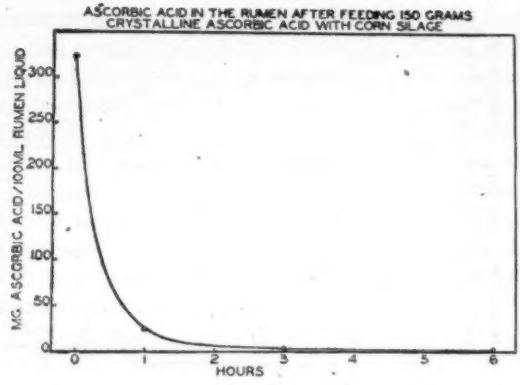

FIG. 3

Effect of Microorganisms. Kendall and Chinn (15) reported that ascorbic acid-fermenting microorganisms are less numerous in the rumen than the non-ascorbic-acid-fermenting types. In order to determine the role of microorganisms in the destruction of ascorbic acid in the rumen, an *in vitro* study was performed in which a sample of rumen contents was sterilized by autoclaving and then incubated in the *in vitro* apparatus. The *in vitro* apparatus was essentially a constant temperature (40° C.) water bath in which the sample of rumen contents was suspended in a rubber balloon attached to a hinged arm. The end of the arm opposite the hinge was lifted and dropped every 20 seconds by means of a revolving eccentric in order to simulate the peristaltic action of the rumen. Figure 5 shows the slower rate of *in vitro*

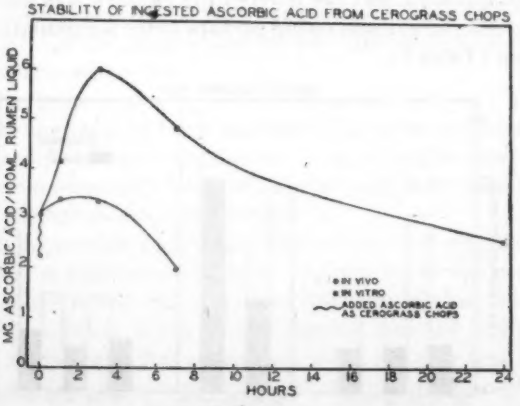

FIG. 4

TABLE 1

A comparison of in vivo with in vitro destruction of ascorbic acid in rumen "liquid" added in the form of "Cerograss Chops"

Time	Additions	Ascorbic acid in rumen "liquid"	pH of rumen "liquid"
hours		*mg. per 100 ml.*	
		in vivo	
Start	None	2.23	.....
Start	*Cerograss chops*	3.05	5.95
1		3.36	5.70
3		3.34	5.69
7		1.98	6.41
		in vitro	
Start	*Cerograss chops*	3.05	5.95
1		4.14	5.59
3		6.00	5.30
7		4.82	5.15
24		2.56	5.02

destruction of ascorbic acid in the sterilized rumen contents as compared with the unsterilized rumen contents.

The *in vivo* studies were continued but in a different manner. The rumen was completely emptied, flushed with warm water and again emptied after which the cow was allowed to partake of the low ascorbic acid ration *ad libitum*. An *in vivo* study of the stability of the ascorbic acid was performed as well as an *in vitro* study. The results of this study are shown in figure 6 titled *without inoculum*. Under the above conditions, there appeared to be little if any tendency for the destruction of ascorbic acid. When this experiment was repeated with the exception that an inoculum of two gallons of the fermenting rumen contents was returned to the rumen, results were obtained as shown in figure 6 titled *with inoculum*. In the latter case there was a definite tendency for the destruction of ascorbic acid.

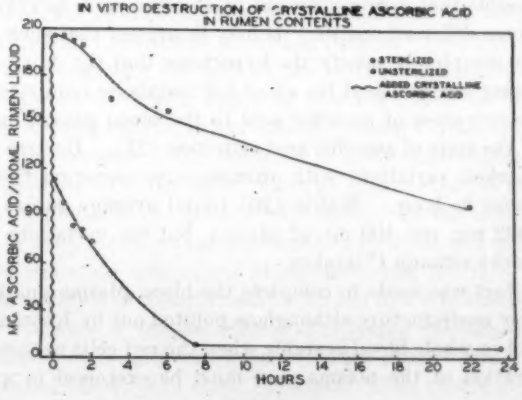

FIG. 5

DISCUSSION

These experiments indicate that the dairy cow is able to function normally for a period of at least 8 months on a ration containing small amounts of ascorbic acid (less than 100 mg. daily). In a four-month period from the 85th to the 224th day of one lactation period the average daily ascorbic acid intake was 99.7 mg. In this period the ascorbic acid excretion in the milk averaged 258 mg. daily and the urinary excretion averaged 57 mg. daily. The excretion of ascorbic acid in the milk alone greatly exceeded the intake. Our studies as well as those of Knight *et al.* (17) show that ascorbic acid is rapidly destroyed during rumen fermentation. It is quite evident therefore that the synthesis of ascorbic acid by the dairy cow must occur in the tissues and/or in some part of the digestive tract other than the rumen.

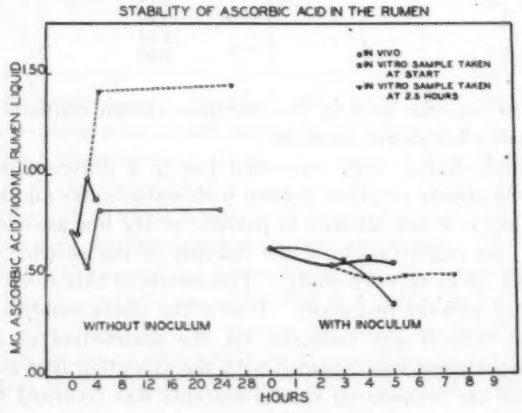
STABILITY OF ASCORBIC ACID IN THE RUMEN
IN VIVO
IN VITRO SAMPLE TAKEN AT START
IN VITRO SAMPLE TAKEN AT 2.5 HOURS
MG. ASCORBIC ACID / 100 ML. RUMEN LIQUID
1.50
1.00
.50
.00
WITHOUT INOCULUM
WITH INOCULUM
0 4 8 12 16 20 24 28 0 1 2 3 4 5 6 7 8 9
HOURS

FIG. 6

It is possible that a ration devoid of ascorbic acid, however impractical, would produce different results. It may be argued that such a procedure is necessary to completely satisfy the hypothesis that the dairy cow is capable of synthesizing ascorbic acid for all of her metabolic requirements.

The concentration of ascorbic acid in the blood plasma has served as a criterion of the state of ascorbic acid nutrition (21). Bortree *et al.* (3) have reported marked variations with animals, also variation from day to day and from hour to hour. Wallis (26) found average values ranging from 0.270 to 0.432 mg. per 100 ml. of plasma, but the variations were not consistent with the vitamin C intakes.

Every effort was made to complete the blood plasma analyses as soon as possible after venipuncture although as pointed out by Kassan and Roe (14) ascorbic acid in whole blood is stable when the red cells are preserved intact. After separation of the plasma care must be exercised to avoid oxidizing

ascorbic acid. In the method of Butler and Cushman (5), in which the deproteinization and the filtration steps are carried out in an atmosphere of carbon monoxide, the possibilities of oxidizing the ascorbic acid are eliminated. A comparison of the latter method with the method reported in this paper was favorable. However, the method employing carbon monoxide is much more time consuming.

The apparent lack of influence of the dietary intake of ascorbic acid on the ascorbic acid potency of the milk produced is borne out by the data presented in figure 1. This fact was recently pointed out by Wallis (25, 26). This worker found that one group of cows on pasture showed the lowest ascorbic acid concentration in the milk while a second group, which was fed an experimental ration low in ascorbic acid, showed a larger amount of ascorbic acid in the milk and was surpassed only by a third group which was fed alfalfa hay and grain.

During the time the cow was on the low-ascorbic acid ration she gave birth to a normal male calf. A sample of colostrum taken less than 12 hours after parturition contained 17.1 mg. ascorbic acid per liter. Three days later the milk contained 16.6 mg. per liter and two weeks later 16.5 mg. per liter. On the basis of these values it appears that the colostrum was not appreciably higher in ascorbic acid content than the milk. These findings, while limited to one animal, are of interest owing to the fact that the impression is quite universal that colostrum is characterized by a higher concentration of ascorbic acid than is found in normal milk. According to Rasmussen *et al.* (20) "This high ascorbic acid content of colostrum was believed to indicate a certain degree of storage of this substance by the cow during the preparturition period." If this assumption were correct, it would follow that a storage of ascorbic acid failed to occur in this instance presumably owing to a scarcity of ascorbic acid in the ration.

On the other hand Kon and Watson (18) concluded that the vitamin C content of colostrum is only slightly higher than that of milk. In their experiment with four cows, three showed a vitamin C content of colostrum higher than the average for the milk of the herd while the fourth had definitely less. To these workers it appeared that the difference between colostrum and milk is much smaller in the case of vitamin C than it is in the case of vitamin A and carotene. On the basis of these observations, no significance should be attached to the "low" ascorbic acid content of the colostrum.

The use of a photoelectric colorimetric method in the determination of ascorbic acid in cows' urine was an attempt to overcome, at least in part, the effect of other reducing substances which decolorize the dye. It was assumed that the reaction of ascorbic acid with the dye was almost immediate, whereas the reactions of non-ascorbic-acid-reducing substances present in cows' urine were slower and continued for some time. The method is admittedly empirical but Evelyn *et al.* (7) state: "The errors are less serious

than those of the ordinary visual titration which may often amount to several hundred per cent."

The urinary excretion of ascorbic acid appeared to follow no general trend and varied from 14.1 to 97.8 milligrams per 24 hours.

Differences in the amount of ascorbic acid excreted in the daytime as compared with the night excretion may be a result of: 1) greater intake of water during the warmer daytime as compared with the cooler night, 2) greater metabolic acitivity during the daytime or 3) assuming that the excretion of ascorbic acid occurs immediately following feeding, a larger excretion in the daytime, because two of the three feedings were made during the daytime collection.

In spite of the rapid destruction of relatively large amounts of crystalline ascorbic acid there always remained a very small but apparently constant amount (about 0.5 mg. per 100 ml. rumen "liquid") of ascorbic acid in the rumen.

SUMMARY

A Holstein cow was maintained in normal physical condition for a period of 15 months on a ration containing very little ascorbic acid. During this period a normal male calf was born. Blood plasma ascorbic acid values ranged from 0.28 to 0.59 mg. per 100 ml. but usually fluctuated between 0.30 and 0. 45 mg. per 100 ml. As the lactation period progressed the total daily ascorbic acid excretion in the milk diminished in a manner paralleling the decrease in milk volume. During this time the urinary ascorbic acid excretion appeared to be erratic with values ranging from 14.1 to 97.8 mg. per 24 hours. The ingestion of large amounts of ascorbic acid increased the urinary excretion of the vitamin very slightly and then only temporarily. The rate of urinary excretion of the vitamin appeared to be greater during the daytime than during the night.

In vivo and *in vitro* rumen studies, made possible with the aid of a rumen fistula, showed that crystalline ascorbic acid in amounts of 150 g. was rapidly destroyed in the rumen. Ascorbic acid supplied in a natural form as *Cerograss Chops,* was also destroyed in the rumen but at a slower rate owing, presumably, to the slower dissolution of ascorbic acid from the natural grasses. These studies also indicated that the destruction of ascorbic acid in the rumen was a result, at least in part, of the action of microorganisms.

The results of these experiments may be summarized, in support of the probable synthesis of ascorbic acid by the dairy cow, as follows: 1) ascorbic acid either in the crystalline form or as a part of a natural product (*Cerograss Chops*) is destroyed rapidly in the rumen; 2) the apparent independence of the cow for dietary ascorbic acid is reflected by normal concentrations of ascorbic acid in the blood and milk in spite of a low ascorbic acid intake over a prolonged period of time; and finally, 3) the ingested intake of ascorbic acid on this lowascorbic acid ration is exceeded by the combined output of the vitamin in the milk and the urine.

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INFLUENCE OF THE FREQUENCY OF TRANSFER OF LACTIC STARTERS UPON RATE OF ACID DEVELOPMENT AND QUALITY OF CHEDDAR CHEESE[1]

A. C. DAHLBERG AND FRED FERRIS[2]

Department of Dairy Industry, Cornell University, Ithaca, N. Y.

It has been the recommended and accepted procedure to transfer starters every 24 hours for cheese making or butter making. In recent years there has been some tendency to assume that such regular transfers may be unnecessary, for starters appeared to be equally good when transfers were not made on holidays or when the mother cultures were transferred two or three times weekly. This has often happened in research laboratories where conditions for carrying cultures are excellent except for regularity of daily transfer.

Occasionally the acid has not developed with sufficient rapidity in our experimental cheese-making process, and the quality of the starter as affected by the frequency of transfer was suspected as a factor. These variations in acid development might be like those observed by Whitehead and Cox (5) who have noted that the rate of acid formation by lactic cultures may become inhibited greatly for no obvious reason. The slow acid development might be due to the culture failing to grow well at 37° C. as observed for some lactic cultures by Whitehead and Cox (6) and by Golding (1). Then too, the frequency of transfer itself may alter the culture, for Sherman and Hodge (4) found that by transferring cultures every 12 hours as compared with 24-hour transfers the total acidity which the culture could produce in 7 days was less. The explanation given was that the fastest growing organisms were capable of producing least total acid and these were secured in largest relative proportions by frequent transfers. The many reasons for slow starters, especially phage, and the proper handling of starters have been well presented by Moir (3) .

This investigation was limited to the frequency of transfer and incubation temperatures as factors in the rate of acid development and the quality of the Cheddar cheese.

METHODS

The culture used was Hansen's lactic culture in dry form and the general procedure for handling was that of Hales (2). It was carried in mixed morning's milk from the University herd. The milk was pasteurized in flowing steam for 70 minutes and its temperature was at 190° to 210° F. (86.6° to 98.8° C.) for 60 minutes. It was then cooled in flowing water to

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[2] Now with the General Foods Corporation, Hoboken, N. J.

70° F. (21.1° C.) for inoculation or the cooling was finished in ice water before placing in a refrigerator at 32° to 40° F. (0° to 4.4° C.). In the latter instance the milk was warmed by water to 70° F. before inoculation. The milk containers were quart glass milk bottles covered with inverted beakers. 500 ml. of milk were used in each bottle. Transfers were made with sterile pipettes.

After the original culture had been transferred for a week and was very satisfactory in growth rate and quality, it was then used in the experiment. One starter designated as regular starter was carried by always inoculating freshly pasteurized milk with enough starter, 0.6 per cent throughout most of the experiment, to give a properly set starter in 16 to 18 hours at 70° F. The starter was then cooled in ice water without breaking the curd and was reset every 24 hours. When this starter was used in cheese making the freshly coagulated starter was taken 16 to 18 hours after inoculation and it was not cooled.

Another starter which was designated as old starter was made from the original culture. The pasteurized milk was cooled and held for three days at 32° to 40° F. It was then warmed to 70° F., inoculated with 0.6 per cent of culture and incubated at 70° F. for 16 to 18 hours to properly coagulate. The starter was then cooled in ice water and stored at 32° to 40° F. for two days. The two-day-old starter was then inoculated into three-day-old pasteurized milk. The starter was never transferred daily. When this starter was used in cheese making the freshly coagulated starter was taken 16 to 18 hours after inoculation to secure an actively growing starter of an age comparable to that of the regular starter.

Starters were also transferred daily in the regular way but using two-day-old pasteurized milk. They were also transferred every third day using freshly pasteurized milk. The differences secured were minor and it was thought best to use only the combination of the inoculation of old starter into old pasteurized milk as the check against regular starter. The starters were carried for several months without renewal but they were compared with starters freshly prepared from a new Hansen's dry lactic culture.

Small batches, 4,000 ml., of pasteurized milk were made into Cheddar cheese curd to determine the activity of the starters. The usual inoculation was one per cent.

Morning's milk from the University herd was divided into two lots of 300 pounds of milk which were made into Cheddar cheese. One per cent of the regular starter transferred daily was used in one vat and one per cent of a fresh transfer of the old starter transferred every third day was used in the other vat. Both batches of cheese were handled identically and the experiment was repeated a month later. The cheese was cured for two weeks at 60° F. (15.5° C.) and was then held at 50° F. (10° C.).

RESULTS

Acid Development and Quality of Mother Starters. The acidity and flavor quality of the two starters were determined daily for several months. At times it was thought that there was more flavor in the starter transferred daily, but careful checking soon showed that it was impossible to consistently tell one starter from the other. Furthermore, there was no difference in the rate of acid development in the two different starters (table 1) that could be associated with the frequency of transfer of the culture. These results were contrary to expectations as it would appear that daily transfer should give more rapid acid development than transfer every third day.

Acid Development in Milk Held at Cheese-Making Temperatures. The regular and old starters were used after 18 hours' growth at 70° F. A one per cent inoculation was made into freshly pasteurized milk. One lot was

TABLE 1

Titratable acidity in various regular and old starters, selected at random, after inoculation with 0.6% regular or old starter and 18 to 20 hours' incubation at 70° F.

	Starter No.									
	1	2	3	4	5	6	7	8	9	10
	percentage acidity									
Regular, daily transfers	0.78	0.81	0.78	0.83	0.86	0.80	0.77	0.92	0.82	0.79
Old, 3-day transfers	0.76	0.80	0.80	0.83	0.91	0.88	0.83	0.86	0.78	0.75

Note: Each batch number represents starters inoculated on the same day.

held in duplicate at 86° F. (30° C.), another at 100° F. (37.7° C.), while another lot was held for 2 hours at 86° F. followed by 6 hours at 100° F. Acidities were determined every other hour for 8 hours to determine the rate of acid development under temperatures and times comparable to those used in cheese making.

The rate of acid development at 86° F. was very uniform for both the regular and old starters (table 2). When the starter was held continuously at 100° F. the rate of acid development was greatly reduced but the old starter was more active than the one that was transferred daily. For some reason the starter transferred every third day had a slightly higher optimum growth temperature than the starter transferred daily. Too much significance should not be given to this small difference. When the starters were incubated at 86° F. for two hours before incubation at 100° F., the acid development was noticeably faster than when incubated at 100° F. only and there was no difference between the two starters. Incubation at 86° F. followed by incubation at 100° F. gave acidities satisfactory for Cheddar cheese making, but continual incubation at 100° F. gave too low acid.

Acid Development in the Cheese Making Process. Fresh transfers of the regular and old starters were made into milk pasteurized at 143° F.

TABLE 2

Rate of acid development in milk held at various temperatures when inoculated with regular starters transferred daily and old starters transferred every third day

Hours	86° F.				100° F.				86° F. for 2 hours 100° F. for 6 hours			
	Regular		Old		Regular		Old		Regular		Old	
	1	2	1	2	1	2	1	2	1	2	1	2
0	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17	0.17
2	0.21	0.21	0.21	0.20	0.20	0.20	0.20	0.20	0.21	0.22	0.21	0.20
4	0.31	0.32	0.32	0.30	0.23	0.21	0.25	0.24	0.29	0.35	0.32	0.27
6	0.64	0.65	0.65	0.62	0.24	0.25	0.30	0.33	0.42	0.52	0.51	0.45
8	0.78	0.77	0.78	0.76	0.25	0.31	0.41	0.50	0.50	0.58	0.58	0.56

Note: The acidities for batches 1 and 2 represent average of duplicate results obtained on different days and the tests on each batch were made with the same milk.

(61.7° C.) for 30 minutes. The inoculation was one per cent and the milks were made into cheese using 4,000 ml. of milk per batch. The temperatures were varied to study the activity of the two starters.

In the first experiments the milk was set at 86° F. or 100° F. and held at these temperatures for the 6 hours usually required to obtain curd ready for milling. The milk held at 86° F. produced abnormally high-acid curd due to rapid growth of the culture at this temperature and the high moisture content of the curd (table 3). The old starter produced the lower total acid. When the milk was set at 100° F. the acid development was too slow for satisfactory cheese making and there was no difference in the results secured with the two starters. It should be noted that in milk held at

TABLE 3

Rate of acid development in cheese made on a definite time schedule from milk inoculated with starters transferred at daily and 3-day intervals and with several variations in setting, cooking, and matting temperatures

Series	Temperature			Acidity of whey at milling							
				Fresh starter *				Old starter			
	Set	Cooked	Matted	1	2	3	4	1	2	3	4
1	86	86	86	0.97	0.94	.....	.....	0.96	0.81	.....	.....
1	100	100	100	0.34	0.18	.....	.....	0.32	0.20	.....	.....
2	86	86	86	0.68	0.80	.....	.....	0.62	0.67	.....	.....
2	86	100	100	0.58	0.78	.....	.....	0.47	0.63	.....	.....
3	86	100	100	0.69	0.58	0.54	0.50	.....	.....	0.48	0.49
3	86	100	86	0.54	0.64	0.51	0.54	.....	0.40	0.40	0.46
4	86	100	100	0.62	0.66	0.61	0.75	0.60	0.66	0.56	0.63
4	86	100	100	0.54*	0.66*	0.51*	0.58*	0.49*	0.59*	.....	0.58*

Note: In each series the batch number given under acidity represents cheese made at the same time from the same milk according to the appropriate time schedule of H. L. Wilson (B.D.I.M. 947) allowing 7 hours from adding the starter to milling.

* Starters were held 24 hours after coagulation before using for inoculation.

100° F. the old starter was the more active so that the results secured with milk and with milk made into cheese do not agree.

In the second experiments the increase in acidity at 86° F. throughout the cheesemaking process was compared with the usual process in which the milk was set at 86° F. and the curd was cooked to 100° F. The acid developed faster at 86° F. and the starter transferred daily gave the more rapid acid development.

Since the cultures grew most rapidly at 86° F. it was believed that the rate of acid development could be increased by cooling the curd back to 86° F. following cooking at 100° F. The data (table 3), show that the acid

TABLE 4

Scores and comments on flavor of raw milk cheese cured at 50° F. made with starter transferred daily and with a starter freshly transferred from one regularly transferred every third day

	Starter transferred daily		Old starter, fresh transfer	
	1	2	1	2
	114329	1445	114329	1445
Acidity of whey at milling	0.43	0.55	0.36	0.47
4 months' scores:				
Judge 1	92	92	91 less flavor	89 unclean
Judge 2	93½ feed	90++	91 unclean	89+ unclean
Judge 3	92½ feed	90++	91 unclean	89+ unclean
Judge 4	92½ feed	91+	91 unclean	89+ unclean
8 months' scores:				
Judge 1				
Judge 2	91½+++ over-cured	90+++	91+++	92+++ unclean
Judge 3	91½++ unclean	89½++ unclean	91++ unclean	92++ unclean
Judge 4	92½+++	90½++ unclean	92+++	92++

+ slight cheese flavor, ++ distinct cheese flavor, +++ strong cheese flavor.

increased as rapidly in the curd held at 100° F. as in the curd cooled to 86° F. after cooking, and the rate of increase in acidity was satisfactory in all cases. Apparently when bacterial multiplication of these cultures was commenced at 86° F. before cooking to 100° F. the acid developed satisfactorily at 100° F. as well as at 86° F. In every instance the acid developed more slowly in cheese inoculated with the old starter.

In the last series of tests some of the starters were aged one day before using. In most instances, the aging of the starters slowed down acid development but not to a great extent (table 3). Again, in these experiments the starter transferred daily produced acid most rapidly.

Influence of the Starters on Cheese Quality. One per cent of freshly coagulated starter transferred daily and one per cent of freshly coagulated starter transferred every third day were added to raw morning's milk from

the University herd. The two identical vats of milk, except for the starter, were made into cheese using identical procedures and time schedules. After 4 and 8 months the cheeses were scored by 4 judges[3] who did not know the identities of the samples or the details of the experiment.

As in previous experiments the acidity of the cheese at the time of salting was greatest when the starter used had been transferred daily (table 4).

The scores of the cheese clearly show that after 4 months of curing at 50° F. the cheese made with starter that was transferred daily was better in quality (table 4). It also possessed the more intense cheese flavor, showing more rapid curing. It is very interesting that the cheese made with starter transferred every third day was considered to be unclean in flavor. It lacked that fullness of flavor that is so desired in dairy products. The better quality and more flavor of the cheese made with starter transferred daily was observed by all judges. After 8 months' curing at 50° F. the cheese made with starter transferred daily had decreased somewhat in the quality of flavor, for the cheese was considered to be "over cured" although this comment was not usually made on the score card. This cheese possessed a very intense cheese flavor. One of the cheeses made with starter transferred every third day tended to improve in both quality and intensity of flavor for 8 months at 50° F. It was not "over cured." One lot of cheese made with freshly transferred starter was a little better, the other a little poorer at the end of 8 months at 50° F. than was the cheese made with starter transferred every third day. It is apparent that the cheese made from daily transferred starter ripened quicker to a higher flavor and should have been put in cold storage at 35° F. to have maintained this fine flavor and avoided too much curing.

It should be pointed out, however, that these data are limited to 4 lots of cheese and it would be surprising indeed if this difference would always be obtained since the quality of the milk and the starter, as well as the cheese making procedure, may affect the results.

DISCUSSION

The information secured from these trials on the frequency of transfer of lactic cultures and the temperature of incubation are very helpful in understanding many cases of slow acid development in the Cheddar cheese making process. For example, in May, 1943 there were 4 batches of pasteurized milk made into cheese in our laboratories in which the whey acidities at milling were only 0.23, 0.25, 0.21, and 0.20 per cent. One per cent of starter was used and the time from setting to milling was from 5½ to 6 hours.

[3] The authors are indebted for the scoring of the cheese to K. L. Wilson, U. S. Department of Agriculture, and to W. V. Price, Evert Wallenfeldt, and L. C. Thomsen of the University of Wisconsin.

The reasons for this failure to develop acidity are now apparent. The mother culture was transferred only 2 or 3 times weekly which produced starters that tend to grow poorly at 100° F. or above. The starter was incubated in the cheese milk for only 20 minutes at 86° F. before rennet was added, thus failing to give it time for multiplication to make it possible for the culture to continue its activity at the cooking and Cheddaring temperatures. Finally, the cooking temperature was 102° F. and this temperature is too high for rapid acid development unless the culture has been previously incubated in the cheese milk for a long enough time at temperatures that promote very rapid growth. The acidity in the curd would have been increased by the daily transfer of the culture, incubation of the culture in the cheese milk at 86° F. for 1 hour before adding rennet, and cooking to a lower temperature of about 98° to 100° F.

SUMMARY

When lactic starters were inoculated every day or every third day and carried under excellent conditions, their quality was identical as judged by appearance, flavor, and acid development. When incubated in milk at temperatures used in cheese making, there were slight differences in the starters. When incubated at 86° F. acid development was rapid and the same for both starters; at 100° F. acid development was very slow; and at 86° F. for 2 hours followed by 100° F. for 6 hours the acid development was good and the same for both starters.

When the freshly coagulated starters were used in cheese making the results were not identical to those secured in milk. The greatest difference was that in the cheese making process the starter transferred every third day gave slower acid development in the curd. When inoculated and set in milk at 100° F. the acid development was almost arrested in the curd and both starters gave comparable results. Cooling the cooked curd back to 86° F. did not affect the rate of increase in acid. An initial incubation of the cultures at 86° F. in the cheese milk was very important in securing the desired increase of acid in the curd at higher temperatures. Aging starters generally slowed the increases in acidity.

Cheese manufactured with starters transferred daily developed more flavor of better quality in less time than when made with starters transferred every third day. This was true even though the starters appeared to be of equal quality. The old starters produced unclean flavors in the cheese. However, the cheeses that developed flavor sooner also over-ripened in less time so that they should be put in cold storage earlier to maintain their fine flavor.

The data show that transfer of lactic cultures every third day as compared with daily transfer reduced the acid produced during the Cheddar cheese making process, and incubation at 86° F. in the cheese milk increased the production of acid at the cooking temperature.

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THE KEEPING QUALITY OF PASTEURIZED MILK IN THE NEW YORK METROPOLITAN AREA DURING COOL WEATHER AS DETERMINED BY BACTERIAL COUNTS, PRESENCE OF COLIFORM BACTERIA, AND FLAVOR SCORES*

A. C. DAHLBERG

Department of Dairy Industry, Cornell University, Ithaca, N. Y.

This study was undertaken to determine the keeping quality of pasteurized milk as it exists today on the market of the New York Metropolitan area which includes New York City and adjacent municipalities in New York and New Jersey. It is important to know just how long milk can be maintained in a satisfactory condition at various temperatures. In recent years the quality of milk has improved and the temperature of storage, particularly in the homes, has decreased. Both of these changes should increase the period of time that milk may be held in a fresh, wholesome condition. The problem has both economic and public health aspects.

The improvement of the sanitary quality of milk has been closely connected with numerous studies on the bacterial content of raw milk and subsequent growth at various storage temperatures. It is interesting to observe that although extensive literature exists on the growth of bacteria in raw milk, on the destruction of bacteria by pasteurization and on the recontamination of pasteurized milk, there are only limited investigations on the growth of bacteria in pasteurized milk. Much work has been done on the improvement in the keeping quality due to pasteurization and on flavor changes in pasteurized milk during storage. There is no necessity for a review of the literature on the general subject of bacterial growth in milk and flavor changes for it is voluminous and well known. The research that applies directly to the specific problems studied in the present investigation is more limited and difficult to locate as it has often been part of more extentive studies.

More than 30 years ago some consideration was given to the bacterial development in pasteurized milk by Ayers and Johnson (3) in their noteworthy study of the bacteria that survive pasteurization. Two samples of milk pasteurized in flasks which gave initial counts below 25,000 were held at 70–75° F. and the counts were in the millions in 2 and 3 days. When stored at 46–50° the counts were under 100,000 for 3 and 6 days. One sample of pasteurized milk with an initial count of 12 gave a count of 20,000

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after 3 days at 70–75° and 4600 in 9 days at 46–50° Thereafter, the counts were excessive.

Mott and Mazer (5) collected samples from vehicles on the streets of Boston in March, April and May, 1942, and stored them in a modern refrigerator at 40° F. The 22 samples of certified-pasteurized milk had an original arithmetic average plate count of 8 and after 5 days the count was 770. The 12 samples of grade A-pasteurized milk began storage with a plate count of 300 which raised to 190,000 in 4 days. The 12 samples of grade B-pasteurized increased from 6000 to 130,000 in 4 days.

That same year, Nicholas and Anderson (6) collected milk from two dealers and stored it at 40° F. The bacterial plate count on the freshly pasteurized milk varied from 1000 to 94,000. Based upon the changes in flavor and bacterial plate counts the conclusion is drawn that "pasteurized or homogenized-pasteurized milk may be stored in the home electric refrigerator at an average temperature of 40° F. for a period of 2 weeks or possibly longer under average conditions before spoilage will occur." The bacterial counts did not increase greatly according to their graphs.

Last year a very extended study of alternate-day milk delivery was reported by Bressler, Anderson, Clarke, and Bilenker (4). They wish to avoid rigidly controlled laboratory conditions and held the milk samples at room temperature, in an ice box, a mechanical refrigerator, and a creamery milk room to simulate practical conditions. A study of their tables shows these temperatures for each type of storage to vary from 70 to 87, 48 to 83, 30 to 68, and 18 to 44° F. Both raw milk as received at the pasteurization plants and the pasteurized milk and raw milk as sold in Connecticut markets were collected in June and July for the study. The authors conclude that milk spoiled in 24 hours at room temperature. The flavor was good for 3 days for pasteurized milk in an ice box and for 4 days in a mechanical refrigerator. Cream plugs formed at the warmer temperatures. Pasteurized milk kept satisfactorily for 2 days in an ice box and 3 or 4 days in mechanical refrigerators.

METHODS

In this study the milk samples were obtained from 6 milk plants in the New York Metropolitan area that processed daily about 800,000 quarts of milk or about $\frac{1}{8}$ of the entire milk receipts of the area. Two plants pasteurized their milk by the high-temperature short-time process with a minimum of 160° F. for 15 seconds, while the other 4 plants pasteurized by the long-hold process at a minimum of 143° F. for 30 minutes.

All milk samples for the complete study were collected in October. The weather was cool enough to aid in holding down bacterial multiplication and the time was near enough to summer feeding conditions to still be in the season when oxidized flavors were not prevalent. The period favored optimum keeping quality. Samples were also collected for flavor scores in February,

following 2 months of severe winter. This was done because oxidized flavor more often develops in the later winter season.

On 3 consecutive Monday mornings each plant took 54 quarts of regular pasteurized milk in a continuous series from one bottle filler to try to obtain the same kind of milk in each bottle. The bottles were marked at once. Thirty-six quarts of the milk at each plant were placed in crates, and brought to the laboratory at once. Eighteen quarts of this milk, known as plant samples, were divided into 3 lots for storage at 3 temperatures. Eighteen quarts of this milk, known as plant samples held at room temperature for 6 hours, were placed in a room for 6 hours which was at 70° to 75° F., and were then divided into 3 lots for storage. This treatment simulated milk left on the doorstep for 6 hours before putting it in the refrigerator. The other 18 quarts of milk at the plant were placed into crates, iced, and then loaded on a retail route truck. When this truck had completed its milk deliveries to the homes and had returned to the plant these quart bottles of milk were delivered to the laboratory. These samples, known as route returns, were divided into 3 lots for storage. There were 6 quart bottles of milk from 6 different plants in each group for study each day. Since the study was repeated on 3 consecutive weeks, 18 quarts of milk were used for each individual test.

The 3 lots of milk from the 6 plants were each stored at 35°–40°, 45°–50°, and 55°–60° F. The lowest temperature represented the coldest temperature that might be used in a mechanical refrigerator in the home or in a milk plant, the medium temperature represented that which might be reasonably expected in an average ice box in the home, while the highest temperature was about as warm as any ice box could be and still consider it refrigerated at all. Any cool temperature above 60° F. might be classed as room temperature. Temperatures were secured by indicating thermometers in quart bottles of water and by recording thermometers in the room.

Tests were made on the milk when fresh and after 1, 2, 3, and 4 days' storage. The flavor of the milk was also determined after 7 days. A different quart bottle of milk was used each day to avoid the storage of milk in bottles that had been opened. The standard plate count (1) was made using tryptone-glucose-extract-milk agar incubated at 37° C. Tests for bacteria of the coliform group in 1 ml. of milk or in proper dilutions were made by standard methods pouring duplicate plates of desoxycholate agar incubated 24 hours at 37° C. and partially confirming atypical small red colonies by streaking on eosin methylene blue agar or transferring to lactose fermentation tubes. One ml. samples of milk were also transferred to 3 tubes of brilliant green lactose peptone bile fermentation tubes and incubated at 37° C. for 48 hours. The brilliant green fermentation tube results were never confirmed. No coliform tests were completed. The milk was scored according to the flavor score standards of the American Dairy Science Association adopted in 1941 as reported by Roadhouse and Henderson (7).

RESULTS

Standard Plate Counts. The presentation of the bacterial counts may be made in several ways with each presentation subject to some criticism. It was believed that the minimum, maximum, and arithmetic average gave the most instructive picture with occasional high counts exerting their greatest influence. In this manner the significance of the exceptional high counts was not minimized.

The data on the quart bottles of pasteurized milk are shown in table 1. The vertical column headed "0 day" gives a check on the accuracy of the work. There were 18 different quart bottles of pasteurized milk used for each average at each temperature, but since the 3 different temperatures could not affect the counts in the brief time required for the platings and all of the

TABLE 1

Standard plate counts on pasteurized milk in quart bottles collected at 6 New York Metropolitan Plants on 3 consecutive weeks in October and stored at 3 different temperatures

Temperature of storage, ° F.	Range in S.P.C.	Age of milk				
		0 day	1 day	2 days	3 days	4 days
35–40	Minimum	6,000	6,000	3,000	3,000	3,000
35–40	Maximum	23,000	21,000	31,000	14,000	18,000
35–40	Average	12,900	11,400	11,900	8,000	9,400
45–50	Minimum	5,000	5,000	5,000	2,000	5,900
45–50	Maximum	30,000	22,000	27,000	46,000	275,000
45–50	Average	12,000	11,200	12,300	16,600	39,600
55–60	Minimum	4,000	4,000	15,000	64,000	550,000
55–60	Maximum	31,000	24,000	934,000	8,960,000	352,000,000
55–60	Average	12,400	10,400	168,000	1,542,000	35,255,000

Note: Each arithmetic average represents a total of 18 different quarts of milk plated in duplicate for each average count, and 270 quarts were used for all of the counts in the table.

milks were from the same batches, all the data in this column should be identical. It should be pointed out that the minimum and maximum counts were secured from different bottles. The average counts on the 3 identical lots of 18 quarts of milk varied from 12,000 to 12,900, the minimum individual counts from 4000 to 6000, and the maximum individual counts from 23,000 to 31,000. These results are very uniform.

When the plant samples of pasteurized milk were held at 35°–40° F. the bacterial counts decreased and were lower at the end of 4 days than when first collected at the plants. When stored at 45°–50° F. the counts were slightly higher after 3 days due to one higher count, but it was not until the end of the fourth day that the average count increased to 39,600. Those milks held at 55°–60° F. showed no change in count in 1 day, the second day the average count was 168,000 and the maximum count was 934,000, and thereafter the average counts were in the millions.

TABLE 2

Standard plate counts on pasteurized milk in quart bottles collected at 6 New York Metropolitan Plants on 3 consecutive weeks in October, held 6 hours at room temperature, and then stored at 3 different temperatures

Temperature of storage, ° F.	Range in S.P.C.	Age of milk				
		0 day	1 day	2 days	3 days	4 days
35–40	Minimum	6,000	7,000	3,000	3,000	2,000
35–40	Maximum	54,000	21,000	22,000	19,000	24,000
35–40	Average	16,200	12,900	11,700	7,700	9,700
45–50	Minimum	8,000	4,000	5,000	5,000	8,000
45–50	Maximum	47,000	28,000	46,000	115,000	2,432,000
45–50	Average	15,600	13,100	15,300	17,900	275,000
55–60	Minimum	8,000	4,000	10,000	80,000	715,000
55–60	Maximum	29,000	23,000	446,000	35,850,000	294,000,000
55–60	Average	14,700	10,900	119,000	3,778,000	42,400,000

Note: Each average represents a total of 18 different quarts of milk plated in duplicate for each average count, and 270 quarts were used for all of the counts in the table.

Holding the plant samples at room temperature for 6 hours gave small immediate increases in total counts, table 2. The average counts for the milks plated at once were 16,200, 15,600 and 14,700. These averages should be identical. Storage of these samples showed reductions in counts at 35°–40° F. and the milk after 4 days gave counts as low as any in table 1. The milks stored at 45°–50° F. showed no increases in counts for 3 days but the counts made at the end of the fourth day were definitely higher in comparison with those made on milks promptly stored at this temperature. The milks held at 55°–60° F. remained low in count for one day and then increased exactly the same as for the plant samples, a result to be expected, for the samples of milk held 6 hours at room temperature reached a temperature only slightly above 60° F. before being stored at 55°–60° F.

TABLE 3

Standard plate counts on pasteurized milk in quart bottles collected after the milk had been returned from the retail delivery routes to 6 New York Metropolitan Plants on 3 consecutive weeks in October, and then stored at 3 different temperatures

Temperature of storage, ° F.	Range in S.P.C.	Age of milk				
		0 day	1 day	2 days	3 days	4 days
35–40	Minimum	6,000	5,000	4,000	4,000	3,000
35–40	Maximum	41,000	26,000	21,000	20,000	18,000
35–40	Average	13,200	11,200	11,100	8,400	9,400
45–50	Minimum	7,000	6,000	5,000	4,000	5,000
45–50	Maximum	19,000	23,000	23,000	62,000	2,816,000
45–50	Average	12,300	11,900	11,600	13,700	226,000
55–60	Minimum	4,000	4,000	7,000	81,000	605,000
55–60	Maximum	21,000	22,000	795,000	6,610,000	230,000,000
55–60	Average	10,900	10,400	113,800	1,116,000	27,300,000

Note: Each average represents a total of 18 different quarts of milk plated in duplicate for each average count, and 270 quarts were used for all the counts in the table.

The milk that was taken out on the milk delivery routes was iced in the crates. Since the weather was cool in October this milk from the routes was usually below 45° F. Consequently, this milk was not subjected to adverse temperature treatment. The data, table 3, show counts that are essentially identical with the counts for milk secured directly from the plants. The bacterial counts reduced when the milk was held at 35°–40° F., an increase was noted at the end of 4 days at 45°–50° F., and after 2 days at 55°–60° F.

Considering all of the milk in tables 1, 2, and 3 together, it should be noted that the bacterial counts on all samples held at 35°–40° F. were slightly lower after 4 days than in the fresh milk. At 45°–50° F. there was a slight decrease in count for 2 days, on the third day slight increases were observed in the counts, but not until the end of the fourth day did the bacteria increase significantly to an average of 180,000 per ml. At 55°–60° F. there was a very slight decrease in count after 1 day followed by a significant increase to 134,000 at the end of 2 days, and thereafter the count was in the millions.

Presence of Coliform Bacteria. The data in table 4 show the number of samples of milk that were positive for bacteria of the coliform group based upon 1 and 2 positive plates and tubes out of 2 plates and 3 tubes inoculated. Each horizontal column for "0 day" gives results for 18 quart samples of fresh milk at each temperature that should be identical for every temperature as the tests were made before ageing.

The number of positive samples of milk, based upon 1 positive plate or tube, varies from 1 to 4 out of a possible 18 milk samples in each of the 3 lots at each temperature. There was 0 or 1 milk sample positive in both agar plates or in 2 or 3 tubes out of a possible 18 milk samples. The totals, not given in the table, show 9 positive desoxycholate agar plates out of 108 total plates and 6 positive brilliant green tubes out of 162 tubes, each plate or tube containing one ml. of milk. The plates and tubes did not always select the same milks as being positive. For example, in the first tests at 35°–40° F. there were 5 samples selected by 1 tube or 1 plate and no one sample was selected by both methods. At 45°–50° F. the same one sample was selected by both methods. At 55°–60° F. the agar plates selected 3 samples, the brilliant green tubes 2 samples, and the same 2 samples were selected by both methods. These results show a low initial coliform contamination and that very erratic results would be secured if one positive tube or plate were used to indicate a contaminated pasteurized milk.

For pasteurized milk collected at the plant and held at 35°–40° F., there is a definite tendency for constancy in the numbers of coliform bacteria. There certainly is no increase in 4 days. At 45°–50° F. these bacteria showed a slight increase in 3 days which is significant in the number of positive tubes and plates. Several desoxycholate agar plate counts were over

100 and 2 of the 18 milk samples gave 3 positive fermentation tubes. At the end of 4 days at 45°–50° F. half of the milks were positive. At 55°–60° F. there was a slight increase in the milks showing coliform bacteria in 1 day while at the end of 2 days more than half of the milks had become positive. These results indicate that the coliform group started growth in this pasteurized milk as rapidly as the other bacteria.

TABLE 4

The presence of coliform bacteria in pasteurized milk in quart bottles collected at 6 New York Metropolitan Plants on 3 consecutive weeks in October and stored at 3 different temperatures

Age of milk, days	Number of milk samples out of 18 that were positive in 1 and 2 plates or tubes after storage of the milk at 3 different temperatures											
	35–40° F.				45–50° F.				55–60° F.			
	Agar plates		Tubes		Agar plates		Tubes		Agar plates		Tubes	
	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+	1+	2+
	Plant samples											
0	3	0	2	0	1	1	1	1	3	1	2	0
1	1	0	1	0	3	1	2	0	3	1	4	3
2	2	2	1	0	4	2	1	0	13	12	11	10
3	1	0	1	0	6	6	5	3	11	9	10	10
4	1	1	1	1	8	7	7	7	14	12	12	12
	Plant samples held 6 hours at room temperature											
0	4	2	3	3	2	1	2	1	4	2	3	2
1	2	1	1	0	1	1	2	1	7	5	4	2
2	3	2	3	1	10	5	6	3	11	11	9	9
3	2	1	3	1	9	9	7	6	16	16	13	13
4	2	2	2	0	10	10	10	10	17	17	16	15
	Retail route return samples											
0	3	1	2	1	2	1	1	1	2	1	1	0
1	1	1	1	0	2	1	1	0	4	2	3	1
2	3	1	2	1	5	3	1	1	14	13	13	13
3	2	1	1	1	6	5	6	3	15	14	13	13
4	2	2	3	1	9	9	9	7	12	12	11	11

When the milk collected at the plant was held for 6 hours at room temperature the milk warmed to 60°–64° F. and it was promptly tested and placed in refrigerators. The results of the 0 day tests show that the total number of positive desoxycholate agar plates increased from 9 to 15 out of a total of 108 plates and the positive brilliant green fermentation tubes increased from 6 to 16 out of 162 tubes. Storage at 35°–40° F. checked this increase and held it down for the 4 days of the experiment, table 4. When the milk was held at 45°–50° F. there was an increase in positive samples when the milk was 2 days old which is one day sooner than this occurred

for samples placed at once at 45°–50° F. Storage of the milk at 55°–60° F. showed increases in coliform bacteria in one day which again is a day earlier than when the milk was immediately placed in the refrigerator at this temperature.

It is interesting to observe in the plant samples held 6 hours at room temperature that after 4 days at 45°–50° F. there were 10 positive milk samples out of 18 by desoxycholate agar plates with 20 plates positive out of a total of 36 plates, and 10 milk samples out of 18 were positive by fermentation tubes with 29 tubes positive out of a possible 54 tubes. After 4 days at 55°–60° F. there were 16 or 17 positive milk samples out of 18. The agar plates showed 34 positives out of a total of 36 plates while the fermentation tubes showed 46 positives out of a total 54 tubes. Apparently, with proper incubation of quart milk samples practically all pasteurized milk in this study showed bacteria of the coliform group in one ml. samples.

The data for milk returned from retail delivery routes were almost identical with those secured with fresh plant samples.

It was not the object of this study to consider the relative merits of desoxycholate agar and brilliant green fermentation tubes as methods of detecting the presence of coliform bacteria in milk. Nevertheless, the data do have some significance from this standpoint. A total of 810 quart bottles of milk was plated in duplicate with desoxycholate agar to give 1620 plates, and since triplicate brilliant green tubes were inoculated there were 2430 tubes. One ml. of milk was used in all plates except for some samples where high dilutions were necessary to secure the proper number of colonies per plate. One ml. of milk was also used in all fermentation tubes but some tubes were also inoculated with one ml. from a 1 to 100 dilution when the counts were known to be very high. The tests were actually presumptive tests made according to Standard Methods. Completed tests were never made but atypical colonies on desoxycholate agar were partially confirmed by streaking on eosin methylene blue to observe if the colonies were typical, or by transfer to fermentation tubes. It is appreciated that for accurate research a completed test should have been made on each milk sample with a positive presumptive test. However, this is rarely done in commercial or public health work and the technicians doing this research were well trained and skilled and under supervision with long experience in this field. It is believed, therefore, that the data are as reliable as those secured in routine tests made by good commercial or public health laboratories.

The results of the individual tubes and plates, expressed as percentages of the total milk samples, are summarized in table 5 to compare the results secured by the 2 methods as applied to commercially pasteurized milk.

There was 73.7 per cent of the milk that was negative on all 3 fermentation tubes. These samples were chiefly fresh milk, that stored at 35°–40°F., that stored one or two days at the higher temperatures, and some samples

that remained negative even after storage for 4 days at 45°–50° F. and 55°–60° F. Of these negative samples there was 65.7 per cent that was negative on both agar plates, 4.4 per cent was positive on one or both plates, 2 per cent gave counts of 5 to 99 colonies, and 1.6 per cent gave counts of 100 or more. It is apparent, therefore, that either too many tubes were all negative or too many colonies grew on the plates, for an unfortunate discrepancy exists in the data.

When only one positive tube out of 3 was used to indicate positive milk 5.4 per cent was positive and 4.9 per cent gave counts of less than 5 on agar plates. However, since 2.2 per cent of the milk was negative on agar plates it is clear that the results secured by plates and tubes did not agree perfectly. Much better agreement was secured by using 2 or 3 positive tubes to indicate positive milks. Two positive tubes only selected 3.4 per cent of the milk of

TABLE 5

Summation of data secured on 810 quart bottles of milk tested for presence of coliform bacteria by duplicate desoxycholate agar plates and triplicate brilliant green fermentation tubes

Results expressed as percentages of total milk samples tested

Desoxycholate agar plate count	Brilliant green fermentation tubes				
	3 tubes –	Only 1 tube +	Only 2 tubes +	All 3 tubes +	Total
Both plates –	65.7	2.2	0.5	0.1	68.5
Only 1 plate +	3.3	1.2	0.9	0.5	5.9
Both plates +	1.1	1.5	1.0	0.4	4.0
5–9 colonies	1.0	0.0	0.2	0.5	1.7
10–99 colonies	1.0	0.5	0.4	2.0	3.9
100–999 colonies	0.2	0.0	0.4	2.8	3.4
1000 or more colonies	1.4	0.0	0.0	11.2	12.6
Total	73.7	5.4	3.4	17.5	100.0

which 0.5 per cent was negative on agar. About $\frac{1}{3}$ of the samples showed counts over 5. When all 3 tubes were positive, only 0.1 per cent of the milk gave no colonies on agar and most of the counts were 5 or more. By considering the results on 2 and 3 positive brilliant green tubes together, there were 20.9 per cent positive milks, and only 0.6 per cent of them were negative on both desoxycholate agar plates. Most consistent and logical results were secured by 2 or 3 positive tubes indicating positive milk.

Flavor Scores. The freshly pasteurized October milks varied slightly in flavor but not sufficiently to affect the flavor scores. The flavor was excellent and without any defects sufficient to warrant criticism, table 6.

When the milk was held at 35°–40° F. for as long as 7 days it lost some of its fresh flavor and sometimes developed a slightly oxidized or slightly old flavor. Nevertheless, the milk stored at 35°–40° F. for 7 days still possessed a good flavor and was very acceptable for drinking. This was true for all the pasteurized milks irrespective of treatment before storage. It is very

interesting to note that the flavor of the milk stored at 45°–50° F., even for 7 days, was practically identical with that of milk stored at 35°–40° F.

The milk held at 55°–60° F. maintained a good flavor for 3 days with a tendency toward slightly oxidized and old flavors. When the milk was 4 days old the flavor was poor or bad and the milk was not salable. In most cases the flavor was either high acid or sour.

TABLE 6

Flavor scores and criticism comments on pasteurized milk in quart bottles collected at 6 New York City Plants on 3 consecutive weeks in October and stored at 3 different temperatures

Temperature of storage, ° F.	Flavor scores and most frequent comment on milk after storage for					
	0 day	1 day	2 days	3 days	4 days	7 days
	Milk collected at plants					
35–40	40.0	40.0	40.0	39.4	38.8 old	37.9 sl. oxidized; old
45–50	40.0	40.0	40.0	39.0	38.8 old	37.9 sl. oxidized; old
55–60	40.0	39.9	39.9	38.0 sl. oxidized; old	31.3 high acid; sour	
	Milk collected at plants, then held 6 hours at room temperature					
35–40	40.0	40.0	39.9	39.1	38.6 sl. oxidized; old	37.7 sl. oxidized; old
45–50	40.0	39.9	39.8	38.9	38.7 old	37.7 sl. oxidized; old
55–60	40.0	39.9	39.8	37.4 sl. oxidized; old	28.8 high acid; sour	
	Milk collected at plants after return from retail delivery routes					
35–40	40.0	39.7	39.7	39.4	38.7 old	37.7 sl. oxidized; old
45–50	40.0	39.9	40.0	39.0	38.2 old	38.2 old
55–60	40.0	40.0	39.8	38.0 sl. oxidized; old	32.1 high acid; sour	

The samples of milk collected in February were secured directly at the plants and were not held at room temperature for 6 hours or taken out on the milk routes. The flavor scores were almost identical with those for milk collected in October (table 7). The October milks included several samples that developed very slight oxidized flavors which never became intensive enough to be objectionable. The February milks in which oxidized flavor was expected to develop did not show these very slight oxidized flavors. However, one sample developed a pronounced oxidized flavor after 4 days at 35°–40° F.; after 3 days at 45°–50° F.; and each of the 3 lots from this

same dairy developed a high acid flavor in 3 days at 55°–60° F. It is apparent that the oxidized flavor did not develop in the milk as expected during storage in February.

TABLE 7

Flavor scores and criticism comments on pasteurized milk in quart bottles collected at 6 New York City Plants on 3 consecutive days in February and stored at 3 different temperatures

Temperature of storage, ° F.	Flavor cores and most frequent comments on milk after storage for					
	0 day	1 day	2 days	3 days	4 days	7 days
35–40	39.8	39.7	39.5	39.4	38.3* old	37.4* old
45–50	39.8	39.7	39.7	39.3*	38.5* old	37.5* old
55–60	39.8	39.7	39.6	37.9 high acid old	33.6 high acid sour, old	

* 1 sample oxidized out of 18.

DISCUSSION

The data clearly indicate that for best results pasteurized milk should not be stored above 50° F. in the home refrigerator. If no pathogenic bacteria are present, and pasteurization assures this to be a fact, then moderate increases in numbers of bacteria are no health hazard and 60° F. storage might be permissible. However, it should be pointed out that increases in the coliform group accompany increases in other bacteria. Bacteria of the typhoid group grow quite well at 60° F. while none grow significantly in several days at 50° F., according to Wahby and Sherman (9) who conclude from their study of the growth of pathogenic bacteria in milk that "it would appear that there is a decided sanitary advantage in requiring milk to be cooled and held at 50° F., as compared with a temperature of 60° F." Should the milk be accidentally contaminated in the home or otherwise with typhoid or other disease-producing bacteria, the maximum safe temperature of storage for any period of time should not exceed 50° F.

It was observed repeatedly that bacteria of the coliform group increased as rapidly as other bacteria at refrigeration temperatures. The growth of coliform bacteria at 45°–50° F. was slow but significant. This observation agrees with several references. Ayers and Clemmer (2) conclude that "little or no growth of the organisms of the colon-aerogenes group occurs below 50° F.," and a study of their data for 50° F. does show a little growth after storage for 48 hours or longer in some samples. Sherman and Wing (8) found that growth of coli-aerogenes bacteria was stopped in milk cooled below 45° F. It appears that from these references and this study that milk must be cooled to 40° F. to be certain that all growth of bacteria of the

coliform group is prevented, but growth was actually very slow at 50° F. for 2 or 3 days. The observation that the number of positive milk samples increased in freshly pasteurized milk held 6 hours at room temperature emphasizes that all milk samples must be kept well iced between the time of collection and making the test.

The use of the presumptive test for coliform bacteria in pasteurized milk does serve as a useful index of subsequent recontamination, as the literature generally shows that all coliform bacteria are destroyed by pasteurization except for rare heat-resistant strains. The data show that 3.6 per cent of the fresh or aged milk samples gave agar counts of 5 to 1,000,000 colonies and was negative in all 3 fermentation tubes. There was 12.6 per cent of the milk samples with plate counts of 1000 or more, but 1.4 per cent of these high count samples was negative in all 3 tubes. Since there were no milks with none or only 1 positive tube and high counts, it is clear that the bacteria concerned either grew well in the agar alone or they grew both in the agar and in the tubes. The desoxycholate plates gave more positives. Some laboratories are endeavoring to secure more consistent results with the coliform test by using larger inocula. Such a procedure cannot reduce the irregularities very much unless the number of positives are greatly increased. After storage of this pasteurized milk at 55°–60° F. for 4 days, from 11 to 17 samples out of a possible 18 were positive on 3 series of tests. One must assume that most of this pasteurized milk had some bacteria of this group in each quart bottle. The presence of these bacteria probably indicates contamination by equipment and bottles in the plant. Perfection in sterilization in the plants is a goal not yet attained.

The initial quality of the milk and its keeping quality may be affected by season. For example in the summer and fall months the oxidized flavor that sometimes develops in pasteurized milk is not troublesome. In the cool weather the bacterial development is at a minimum but oxidized flavors, except in the fall, may be prevalent. In October, conditions are especially favorable for both good flavor and low counts and the results do show very good keeping quality. In February oxidized flavors did not develop in the milk as expected. The work on flavor and bacterial development should be repeated in midsummer.

SUMMARY

Pasteurized milk was collected in October from 6 milk plants processing about 800,000 quarts of milk daily for the New York Metropolitan area. The freshly pasteurized milk as collected at the plants had an initial standard arithmetic average plate count of about 12,000 colonies per ml. There was 0 or 1 quart of milk out of 18 samples on each of 3 consecutive weeks showing presence of coliform bacteria and a total of 3 positive samples out of 54 quarts as determined by 2 positive desoxycholate agar plates or by 2 positive brilliant green fermentation tubes out of 3, using 1 ml. of milk per

plate or tube. From the 54 bottles of freshly pasteurized milk there were 108 desoxycholate plates poured, of which 9 were positive and there were 6 positive brilliant green bile tubes out of 162. The flavor score of the milk was 40 or "excellent."

Holding the freshly pasteurized cooled milk 6 hours at room temperature to simulate failure to promptly refrigerate delivered milk showed some immediate effects. The standard plate count increased slightly to about 15,000. The number of milks positive for coliform bacteria on 2 plates or 2 tubes was 1 to 3 out of a total of 18 milks on each of 3 consecutive weeks. The flavor score was not changed.

Milk which had been iced and taken on a retail milk delivery route in October was returned to the plant in its original condition.

When the milk was stored at 35°–40° F. the standard plate count was slightly lower after 4 days than when the milk was fresh. The milk samples found positive for coliform bacteria remained constant in count. The flavor score held for 7 days in the "good" class with a score of 37.8 and with no pronounced off-flavors. These results were true for plant samples, plant samples held 6 hours at room temperature, and route return samples.

Milk stored at 45°–50° F. showed a slight decrease in standard plate count after one day. The arithmetic average count began to increase slightly after 3 days and showed a significant increase to 180,000 at the end of 4 days. The bacteria of the coliform group did not decrease and showed a slight increase in the 2-day-old sample. After 4 days the positive samples were 7 to 10 out of 18 total samples on each of 3 consecutive weeks, and several samples gave desoxycholate agar counts of 10,000 to 60,000 colonies. The flavor score held for 7 days as "good" with a numerical average of 38. The pasteurized cooled milk held for 6 hours at room temperature showed slightly higher bacterial counts and more positive coliform tests than shown by the plant samples.

Milk stored at 55°–60° F. showed a slight decrease in standard plate count during the first day and at the end of the second day it had increased to an average of 134,000, and thereafter exceeded a million. At the end of the first day the milk showed coliform bacteria in 1 to 5 samples out of a total of 18 for each of 3 consecutive weeks. In 4 days the numbers had increased to 41 positives for 54 samples. The flavor was good for 3 days but on the fourth day the milk was unsalable due to high acid or sour flavors. The same results were secured for plant samples, plant samples held 6 hours at room temperature, and route return samples, except that samples held 6 hours at room temperature showed more samples positive to the coliform test.

The presence of coliform bacteria was determined most consistently by considering milk to be positive when at least 2 brilliant green bile tubes out of 3 showed gas with 1 ml. inoculations. There were some counts on desoxycholate agar when the bacteria in the milk produced no gas in tubes. The

coliform bacteria began to increase in numbers as soon as the other bacteria at 45°–50° F. and 55°–60° F. The majority of quart bottles of pasteurized milk became positive after 4 days incubation at 55°–60° F. even though tests on the fresh milk were negative. Milk samples taken for coliform tests need to be iced promptly.

Milk collected in February kept as well in flavor as milk collected in October. Oxidized flavor did not develop in the milk as expected.

It was pointed out that refrigerators in the home should not be above 50° F. to best safeguard the healthfulness of milk.

The quality of freshly pasteurized milk and its keeping quality is known to be affected by season, and this study was limited to the cool fall month of October, and a severe winter month of February. The flavor and the bacterial counts should be determined again in the middle of summer to obtain complete information under all seasonal conditions.

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Lucas, P. S.
Marquardt, J. C.
Mueller, W. S.
Price, W. V.
Pyenson, Harry
Reece, Ralph P.
Roberts, Henry E.
Salisbury, G. W.
Thomsen, L. C.
Trimble, C. S.
Trout, G. M.
Waugh, R. K.
Webb, B. H.
Weckel, K. G.
Weiser, H. H.
White, G. C.
Yale, M. W.

JOURNALS

American Butter Review
American Milk Review
American Journal of Diseases of Children
American Journal of Physiology
American Journal of Public Health
Archives of Pediatrics
Australian Journal of the Council for Scientific and Industrial Research

Biochemical Journal

Canadian Dairy and Ice Cream Journal
Canadian Journal of Public Health
Canadian Journal of Research
Certified Milk
Cornell Veterinarian

Dairy Industries
Dairy World

Endocrinology

Food in Canada
Food Industries
Food Manufacture
Food Research

Ice and Refrigeration
Ice Cream Field
Ice Cream Review
Ice Cream Trade Journal
Industrial and Engineering Chemistry

Journal of Agricultural Research
Journal of Agricultural Science
Journal of American Medical Association
Journal of American Veterinary Medical Association
Journal of Animal Science
Journal of Bacteriology
Journal of Biological Chemistry
Journal of Dairy Research
Journal of Dairy Science
Journal of Endocrinology
Journal of Experimental Medicine
Journal of General Physiology
Journal of Genetics
Journal of Heredity
Journal of Infectious Diseases
Journal of Milk Technology
Journal of Nutrition
Journal of Pathology and Bacteriology
Journal of Physical Chemistry
Journal of Physiology
Journal of Veterinary Research

Lancet
Le Lait

Milk Dealer
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New Zealand Journal of Science and Technology

Oil and Soap

Pacific Dairy Review
Proceedings of Society of Experimental Biology and Medicine

Refrigerating Engineering

Scientific Agriculture
Southern Dairy Products Journal

SPECIAL PUBLICATIONS

Federal Dairying and Bacteriological Establishment, Liebefeld, Berne, Switzerland

International Association of Ice Cream Manufacturers
International Association of Milk Dealers

National Institute for Research in Dairying, Reading, England
New York Association of Dairy and Milk Inspectors

Prussian Dairy Research Institute, Kiel, Germany

State Agricultural Colleges and Experiment Stations

The Royal Technical College, Copenhagen, Denmark

United States Department of Agriculture

ABSTRACTS OF LITERATURE

BOOK REVIEWS

308. Food Regulation and Compliance. Vol. I. ARTHUR D. HERRICK, Member of the New York and Federal Bars. Revere Publishing Co., New York. 1944.

The author has endeavored to present his material in such a manner that the layman can understand the interpretations of the 1938 Food Drugs and Cosmetics Act without becoming lost in a maze of legal phraseology. Numerous instances are cited when necessary to illustrate compliance and non-compliance with the act and in so far as standards have been adopted by FSA they are explained, though details or standards are omitted for the most part. The existing standards for foods in general and milk products in particular can be obtained from the Office of Distribution, War Food Administration. This book will be of great value as a reference to executives of all concerns manufacturing food products entering into interstate movement.

The following partial list of chapter headings will serve to indicate subjects which will be of general interest to all food manufacturers. Foods Subject to Regulation; Misbranded Food Products; Labels and Labeling; False and Misleading Representations; Food in Package Form; Net Contents of Package; Imitations and Fraudulent Products; Violations of Food Standards; Unstandardized Food Products; Statement of Ingredients; Special Dietary Foods; Chemical Preservatives; Artificial Flavoring and Artificial Coloring; Label Display and Prominence; and Deceptive Packaging of Foods. L.M.D.

309. Flavor. ERNEST C. CROCKER, Research Chemist, Arthur D. Little, Inc., Cambridge, Mass. McGraw-Hill Book Co., Inc. 1945.

This book initiates a series in Food Technology by McGraw-Hill to follow a program of publication outlined by an advisory committee of outstanding men of industry, research and technical education in the food manufacturing and production fields under the chairmanship of L. V. Burton, Editor, Food Industries. Because flavor is such an important factor in the consuming public's acceptance of food products, every food technologist should be thoroughly acquainted with the physiology, chemistry, and psychology of flavor perception. Even the sales manager can profit from a more comprehensive knowledge of flavor. In many cases sales and production are cooperating in flavor testing of the food product which is being promoted. Of two competing food products identical in cost of manufacture and distribution and unit selling price, the one enjoys greater total sales than the other

because of superior flavor appeal. In the dairy industry flavor is elemental and fundamental with milk its raw material that determines to a great extent the ultimate flavors of processed and manufactured milk products. Greater recognition has been given the role of flavor in all branches of the dairy industry in later years but it has been one major food industry which for many years has maintained score cards for the quality measurement of milk and milk products in which flavor has been given a sizeable weighting. During the last four or five years 45 points out of 100 have been apportioned flavor in score cards for milk and cream, butter, cheese and ice cream. This applies particularly to educational score cards. The U.S.D.A. Bureau of Agricultural Economics originally set up in the case of butter, a scoring system based primarily on a flavor score designation, and for cheese a flavor score of 30 instead of 45 to be used in establishing U. S. market grades. This particular portion of the book could have been more valuable if these facts had been incorporated.

The author presents an interesting treatment of odor classification, Zwaardemaker's nine, Henning's six, and his own and Henderson's four. These four are *fragrant*, or sweet; *acid* or sour; *burnt* or empyreumatic; and *caprylic*, goaty, or oenanthic. It is stated when the sensations are strong this arrangement places them in the order of their interest to most people. *Fragrant* is most liked, *acid* next, *burnt* is slightly disliked and *caprylic* is much disliked. These four fundamental odor sensations have been embodied by Crocker and Henderson in a quantitative notation system of 0 to 8 digits for each element. Thus any odor may be represented by a four-digit number varying in digit values from 0 to 8 according to the intensity of contributory values of each of the four individual odor factors. This system lends itself to setting up comparison standards of harmless substances that are safe to smell (whiff) repeatedly and that remain constant in odor over a long period of time.

The language of flavor is dealt with in one chapter and in it in addition to terms of strictly flavor significance as the ordinary person considers them those of the *feeling* sense are given attention. Too often an otherwise satisfactory food product lacks flavor appeal because of the undesirable *feeling* or touch reactions engendered by lip, tongue, and mouth, and even throat contact.

Influences of processing on flavor, flavor changes in storage, organoleptic technique, consumer-testing of foods, the art of the chef, beverage appraisal by taste and commercial quality scoring are other subjects discussed. One chapter on Volatility as a Property of Odoriferous Substances (Chap. 8) contains a long table listing chemicals in their order of volatility at 20° C. There is included a classification table based upon evaporation time in hours of one drop of substances held on paper at 20° C. in still air. This book should be in every food plant laboratory and should be read by both control, production and sales executives. L.M.D.

BREEDING

310. The Growth, Development and Future of Artificial Breeding. J. W. BARTLETT, N. J. Agr. Expt. Sta., New Brunswick, N. J. Cert. Milk, *20*, No. 227: 3. March, 1945.

The growth and development of the first cooperative artificial breeding association organized in New Jersey and probably the first in this country is discussed. The chief reason given for the success of this first cooperative is that it was run as a business on a business basis. A state-wide survey on the results of its first few years of success revealed that of 120 farms on which heifers had made one or more records, the average increase in milk production was approximately one quart per day per cow. Three types of organized artificial breeding programs are predicted for the future: namely, (1) statewide or central unit, (2) county, district or community unit and (3) private unit sponsored or owned by veterinarians or breeders. It is also pointed out that artificial breeding of dairy cattle may be a means of reducing post-war costs of milk production to meet stiff competition. W.S.M.

BUTTER

311. Research Points to Better Butter Values. E. M. HARMAN, Natl. Dairy Council, Chicago, Ill. Cert. Milk, *20*, No. 231: 5. July, 1945.

Nineteen states, the Bureau of Dairying and the office of Experiment Stations have cooperated since 1941 in a study to determine the variation of vitamin A values in butter at the time it was manufactured and after storage. While this study will be continued, over 3,500 representative samples of butter have been analyzed. From 14 states, which make almost 64 per cent of all the butter in the United States, winter butter contained approximately 11,000 units of vitamin A per pound and summer butter contained approximately 18,000 vitamin A units. Results so far obtained also indicated little or no loss of either vitamin A or carotene even when stored for long periods of time. Studies of butter found on the counters proved the vitamin A potency to be almost exactly the same as when manufactured. W.S.M.

312. The Manufacture of Margarine, Developments in Methods and Raw Materials Since Mege Mouriès. A. J. ANDERSEN. Food: 37–42. Feb., 1944.

"The various steps in the process of manufacture of margarine as devised by Mege Mouriès are still those which govern the manufacture of margarine," namely (1) selecting and preparing a suitable mixture of oils and fats; (2) preparing the milk for producing flavor and aroma comparable to

butter; (3) emulsifying the fat blend with the aqueous liquid; (4) crystalizing the fluid emulsion; (5) working and (6) packaging. With the development of the hydrogenation process for unsaturated oils the manufacturer has been able to utilize many more oils such as whale and other marine animal oils. Melting point, texture, flavor and plasticity are factors given attention "in order to obtain a close similarity to butterfat. . . ." A right proportion of solid and liquid glycerides in the finished product is obtained by use of a melting dilatation test. A diagram for a number of oils and fats as compared with butterfat is shown. Best table margarines from texture and plasticity standpoint have temperature range of from 10° to 30° C. for hot bakeries use 25° to 35° C. The proportions of milk now used range "from nothing to 25%" . . . or more dependent upon intensity of flavor and aroma desired and to provide greater stability against deterioration. With certain fat and oils mixtures "milk gives a noticeable protection against oxidative rancidity, but on the other hand, milk increases the risk of hydrolytic rancidity." "Margarine manufacturers have taken full advantage of the increasing knowledge and improving technique in the dairy industry. . . ." The milk ripening process comparable to starter methods used in the dairy industry whereby a pH value of 4.3 to 4.5 is obtained is described. The part played by the margarine manufacturer who since he "relied on ripened milk to produce the desired aroma in margarine, he obviously considered it important to try and find out what causes the so-called butter aroma . . ." is likewise traced. *Betacoccus cremoris* was one organism used and "some manufacturers use high-grade aromatic butter as the source of a balanced culture. . . ." The emulsification process is described as a churning process and the machines used as a churn when "the emulsion emerges as a thick cream." The stabilizers used, the cooling and crystallization, the kneading and working and packaging methods and equipment used are all comprehensively described by the author for both European and United States margarines. Margarine is said to be largely made "as household margarine, that is, with butter as pattern. . . ." Sanitary requirements for plant operation and for equipment materials are likewise discussed. C.S.T.

CHEESE

313. Italian Cheeses . . . in Italy and America. ROBERT S. BREED, New York State Agr. Expt. Sta. Milk Plant Monthly, *34*, No. 4: 22–23, 64. 1945.

War conditions have disturbed the imported cheese industry, particularly Swiss, Camembert, Blue, Roquefort and Italian Cheese. As a result importations from other sources and increased interest in domestic manufacture of this type of cheese have occurred in this country. The average

American uses the term "Italian cheese" with little understanding of the nature of these cheeses. Many varieties occur in Italian cheese, as to the type of milk, ripening, dryness and purposes for which the cheese is intended. The grating type cheeses from Italy are made by the scalded curd process. Cheeses surface-ripened carry a great variety of names. Italian "Bel Paese" is perhaps the best known type in America. Ripening of this cheese is somewhat similar to that of limburger. The largest development of the hard grating cheese in America has been that of Parmesan made from cow's milk rather than sheep's milk, this development occurring chiefly in the Northern Wisconsin area. A certain amount of Italian type soft cheeses are being made in New York State. There is a real possibility that this industry will retain sufficient vigor to develop and maintain its position in the post-war period. G.M.T.

314. A Phosphatase Test for Cheddar Cheese. GEORGE SANDERS AND OSCAR SAGER, Dairy Res. Lab. U. S. Dept. Agr. Milk Plant Monthly, *34*, No. 6: 50, 52–55. 1945.

A modification of the phosphatase test used in testing milk to determine the adequacy of pasteurization has been developed likewise for testing cheddar cheese. The method is described fully from the preparation of standards to performance and interpretation of the test. From studies made on the test, it was found that the addition of as little as 0.1% of raw milk, or a decrease of 2 degrees in pasteurization temperature of 30 minutes, could be detected in the cheese test. Even raw milk cheese five years old gave strongly positive values. G.M.T.

CONCENTRATED AND DRY MILK; BY-PRODUCTS

315. The Whey Problem. T. G. DAVIS, D.SC., PH.D. (London). The National Inst. for Res. in Dairying, Reading. Irish Agr. and Creamery Rev., *14*, No. 138: 19–20. June, 1945.

The author stresses the importance of any cheese factory handling 10,000 gallons of milk daily to provide for the utilization of the whey and cites 4 basic means of utilizing it, namely, (1) unchanged, (2) drying, (3) boiling and (4) microbiological utilization. Under (1) return of pasteurized whey for feeding; the establishment of factory pig farms; the conversion of whey into variously flavored carbonated and bottled drinks as a nutritious alternate to ice cream sodas or for those who could not digestively handle whole milk or to ferment the whey into "whey beer," and to use the whey to dilute molasses used for silage to avoid too much moisture and conserve molasses are means suggested. Under (2) the whey may be condensed, powdered, or converted into milk sugar. Under (3) albumin cheese (Ziger) or albumin for feeding. Under (4) the conversion of whey by addition of chalk and

cultures of *L. bulgaricus* into lactic acid or by addition of molasses to ferment into alcohol or by the addition of inorganic nitrogen and inoculation with yeast a good yield of sedimenting yeast could be obtained and used for cattle feed. Whey butter may be made from the separated whey cream. (The author's suggested utilization of whey by conversion into carbonated bottled drinks, its use in silage and the microbiological conversion of inorganic nitrogen to organic and available cattle feed should be of possible interest to U. S. cheese factories.) C.S.T.

316. **Artificial Bristles from Proteins.** T. L. McMeekin, T. S. Reid, R. C. Warner, and R. W. Jackson, Eastern Regional Res. Lab., U. S. Dept. Agr., Philadelphia, Pa. Jour. Indus. Engin. Chem., Indus. Ed., *37*, No. 7: 685–688. July, 1945.

Coarse casein fiber is made by first mixing 40–100-mesh commercial acid-precipitated casein containing 9% moisture with from 37% to 70% of its weight of water. After standing an hour the hydrated casein is placed in a press, slowly heated to 95° C. and forced through a die from 0.3 to 0.6 mm. in diameter. The fiber is stretched and hardened, under tension, with quinone. A study was made of the properties of the bristles thus produced. The dry tensile strength of casein bristles was less than that of natural bristles, but adequate for most brushes not subject to wetting with water. In water casein bristles absorbed 18% water, became soft and showed a tensile strength half that of the dry bristles. B.H.W.

317. **Future of the Dry Milk Industry.** E. Fred Koller, Univ. of Minn., St. Paul, Minn. Natl. Butter and Cheese Jour., *36*, No. 8: 36. Aug., 1945.

Outlets will have to be found for 500 to 700 million pounds of milk powder for human use. The home market probably cannot absorb it immediately but eventually it may be educated to do so in manufactured products like baked goods, sausages, candy, ice cream, and food mixes. Promotion of the use of dry milk in homes requires development of tested recipes and then sales promotion. The retail price must encourage its use and, considering costs of manufacture and distribution, this should not be impossible. Quality standards must be high or the human-food market outlet may have to be abandoned by some producers. W.V.P.

DISEASE

318. **Abnormal Milk. Its Relation to Public Health with Suggestions for the Production of a Safe Milk.** John E. W. McConnell. Milk Plant Monthly, *34*, No. 4: 26–28, 30, 71–73. 1945.

Health hazards due to milk are divided into three classes: (1) those resulting from growth of micro-organisms, (2) those in which the causative

agents are chemical in nature, (3) and those disorders resulting from food allergies or sensations to foods. While the health departments supervise the production and handling of market milk, it isn't possible for them to exercise constant supervision. Therefore, producers and dealers themselves must guard against constant danger of contamination.

The author discusses briefly milk allergy, chemical poisoning, milk-borne infections and intoxications which include tuberculosis, undulant fever, mastitis, streptococcus food poisoning, septic sore throat, scarlet fever, anthrax, foot-and-mouth disease, food poisoning, gastroenteritis, dysentery, diphtheria, typhoid fever, paratyphoid fever and poliomyelitis.

A brief discussion of the fundamentals of clean milk production is included. Twenty-one references are cited. G.M.T.

FEEDS AND FEEDING

319. Cows Can't Synthesize Minerals as They Do Certain Vitamins. ROBERT L. QUAIT, Limestone Products Corp. of America, Newton, N. J. Cert. Milk, *19*, No. 222: 9. Oct., 1944.

The mineral composition of the dairy ration should have careful consideration because cows cannot synthesize minerals as they do certain vitamins. A total of perhaps twenty or more mineral elements are required for various metabolic purposes. The mineral elements whose functions are better known are: calcium, phosphorus, iron, copper, manganese, cobalt and iodine. The fact that cows store a reserve of manganese in their bodies, when it is present in sufficient amounts in the ration, emphasizes its nutritional significance and the necessity of supplying it in the diet. Since cows lose large quantities of calcium when calving and producing milk, this mineral should be supplied adequately in the diet. W.S.M.

320. Nutritive Value of Roughage for Dairy Cattle. C. F. HUFFMAN, Inst. of Nutr. and Dairy Dept., Mich. State Col., East Lansing, Mich. Milk Dealer, *34*, No. 9: 130. June, 1945.

Roughage can be utilized to best advantages through improved pastures grazed by the dairy cow equipped by nature to economically handle large amounts of roughage. The author cites 3 great losses to curtail or avoid in the production of either legumes or grasses; (1) to harvest at greatest stage of digestibility compatible with nutritive development, (2) harvest as early as practicable in order to cut down on supplementary grain ration and (3) harvest to conserve roughage by proper and recommended cutting, curing and silage methods. C.S.T.

321. Vitamins for More and Better Milk. LOGAN T. WILSON, The Borden Co., New York, N. Y. Cert. Milk, *19*, No. 223: 3. Nov., 1944.

Further evidence from field trials at the Walker-Gordon Laboratory Co.

at Plainsboro, N. J., is presented, indicating that increases in milk production can be obtained by feeding a commercial vitamin preparation furnishing 125,000 U.S.P. units of vitamin D per cow per day. Increases of over 5 lbs. of milk per cow per day were obtained by maintaining milk flow near peak production for a longer period of time. The most outstanding increases occurred with high-producing cows which were on liberal grain feeding. A review is given of some of the recent literature which indicates other benefits that may result from feeding extra vitamins, particularly vitamin A. Points discussed in this connection are vitamin A content of milk, milk flavor, reproductive efficiency, and acetonemia or ketosis. W.S.M.

FOOD VALUE OF DAIRY PRODUCTS

322. Trace Elements in Milk. Prof. L. M. Dorsey, Univ. of Maine, Orono, Maine. Milk Dealer, *34*, No. 9: 108–110. June, 1945.

Trace elements of minerals as found in foods are vital factors in the promotion of growth of the young, in maintaining body tones of adults, and may prove to be exceptionally important in dietary prognosis for the aged. Milk contains these important trace elements or their presence may be produced by feeding mineral supplements to dairy cows. The importance of fluorine in the diet and its occurrence in average milk is discussed, particularly from standpoint of teeth calcification. Milk will also be a source of manganese, copper, iron and iodine in the diet and is most readily available. Despite increased milk consumption from 1924 to 1943, the author concludes that as a nation we are a long way from a dietary saturation point in the consumption of milk. C.S.T.

323. New Developments in Nutrition Research. Dr. Julia Outhouse Holmes, Prof. Nutr. Res., Mass. State Col., Amherst, Mass. Milk Plant Monthly, *34*, No. 2: 22–24, 57–60, 62, 63. 1945.

This paper is an outstanding survey of recent research of nutrition involving milk. The bibliography includes 40 citations. The author points out that the animal body requires about 50 different specific chemical compounds, no one of which can pinch-hit for the other, and that milk contains almost all of these 50 nutrients needed. Formation and reproductive success of animals has been regarded as the most crucial criterion that could be given a diet. However, there are other more crucial tests of the adequacy of a diet.

Proof is that although the human race has existed for centuries, poor teeth, and all sorts of diseases, possibly of dietary origin, exist. Experimental evidence indicates that syntheses of biotin can occur in the human intestinal tract, and that it is possible for the individual to get along without having all the biotin in the form of foods, if we eat the right kind of foods.

The feeding of animals of enriched bread fortified with vitamins did not result in any better growth than those receiving non-enriched bread. Thus it appears that a poor diet cannot be made good by adding one or more of the 50 nutrients that man needs. It was suggested that when milk solids were added to whole wheat bread then we would have a nutritive mixture which could be considered the "staff of life." Riboflavin, one of the most important nutrients needed by the animal, is one of the nutrients which makes milk a superior food and is necessary for the formation of red blood cells. The consumption of a quart of milk daily would supply 70% of the daily requirements of 2.3 milligrams of riboflavin. In addition to the rôle played by riboflavin in the formation of red blood cells, it plays a part also in bone development and in the inactivation of toxic compounds. The other B vitamins found in milk have a real function in inhibiting abnormal growth and disease. Vitamin B_6 is necessary for hemoglobin regeneration, and when absent from the diet anemia not only results, but iron metabolism is abnormal. Man's requirement for vitamin B_6, or pyridoxine, is estimated at 1.5 milligrams per day and is furnished by a good diet. Milk contains about 0.67 milligrams per quart. Folic acid, or B_c, is very important for hemoglobin formation, but milk does not contain much of the vitamin. Milk in its natural state is a poor source of vitamin D which is essential for the older child as well as for the baby. Processing may destroy some of the nutrients of milk, or change them in such a way that the body may not utilize them to the same extent as before processing. For example, light affects riboflavin, also light, heat and oxygen affect the ascorbic acid content of milk. In the light of present knowledge a diet built around the protective foods—one rich in vegetables, eggs, meat, whole grains and milk—still gives us the best diet that scientists can devise. G.M.T.

HERD MANAGEMENT

324. Time Studies in the Dairy Barn. Ivan R. Bierly, Cornell Univ., Ithaca, N. Y. Cert. Milk, *20*, No. 228: 3. April, 1945.

A discussion of time studies made in typical dairy barns and milk houses in New York state and several other states is reported. The purpose of the studies was to show farmers how to obtain more efficient farm operation. The number of hours of labor to care for a cow in a year was found to vary from less than 100 to more than 200. These wide differences in amount of labor to care for a cow could not be explained entirely by the size of herd. Other factors contributing are (1) methods used in doing the work, (2) equipment used, and (3) arrangement of the stables and milk houses. It is pointed out that the greatest opportunities that most farmers have to save time in doing their chores is to reduce the milking time, including stripping, per cow. W.S.M.

325. To Strip or Not to Strip? GEO. H. HOPSON, De Laval Separator Co., New York, N. Y. Cert. Milk, *19*, 224: 9. Dec., 1944.

Hand-stripping is the more common practice on the farm today, although machine-stripping is fast taking its place. In better milking herds the average stripping weights are from 0.1 to 0.5 of a pound per cow. Cows that give a pound or more strippings should be considered incompletely milked. Major causes for excessive strippings are as follows: (1) low vacuum, (2) liners not at proper tension or in poor repair, (3) leaky and worn pulsators, (4) faulty preparation of the animal for milking (5) use of too many units per man, (6) irritations of the skin of the teats, (7) formation of pockets in lower part of udder, and (8) scar tissue at the end of teats or in teat-canal. Incomplete milking is an indication of something wrong in the milking routine and should not be accepted as a necessary evil but should be corrected. Stripping should be practiced only on cows that need to be stripped, and it is highly desirable to build up a herd of cows that do not require stripping. W.S.M.

ICE CREAM

326. Sherbet and Ice Review. Part III. A. D. BURKE, Dairy Dept., Ala. Poly. Inst. Ice Cream Field, *45*, No. 5: 14, 16, 30, 31. 1945.

A slightly tart fruit acid flavor is a distinguishing characteristic of ices and sherbets and legal requirements in many states stipulate a minimum amount of harmless organic acid in these products. The findings of several workers are reviewed to show that considerable variation exists in the acidity of ices and sherbets, but from 0.35% to 0.50% acidity is considered satisfactory. A variation in acidity depending upon the sugar content is recommended. Although citric acid is commonly used, the author states that phosphoric, lactic, tartaric and malic acids also give satisfactory results.

The presence of milk solids in sherbets distinguish them from ices. There is, however, considerable variation in the percentage of milk solids used in sherbets, not only as to preference but also to legal requirements. Various workers are quoted to show that no acceptable standard has been adopted.

The recommended overrun for ices is about 25% and for sherbets about 35%. The author points out the need for establishing basic methods of standardizing quality. W.C.C.

327. Compressed Air. ANONYMOUS. Ice Cream Rev., *28*, No. 5: 24. Dec., 1944.

The many places where compressed air can be utilized to advantage in the ice cream plant are cited. These uses include a can-filling shaft for

continuous freezers, opening of bags for ice cream novelties, lifting of floor trucks to height of transport vehicles, grease pumps, inflating tires and painting work. J.H.E.

328. Six Roads to Bigger Ice Cream Sales. ANONYMOUS. Ice Cream Rev., *28*, No. 6: 26. Jan., 1945.

Gains in the consumption of ice cream can be brought about by following and using the time-tested program of the National Dairy Council. This involves enlisting the support of the medical profession, scientists, educators, and professional workers. These are the opinion-forming leaders who largely determine the food habits of the nation. The leaders can be aided to more fully appreciate the value of dairy products through the means of: personal contacts, educational literature, educational advertising, movies, publicity releases and exhibits and displays. J.H.E.

329. Shall We Sell Ice Cream by Weight? ANONYMOUS. Ice Cream Rev., *28*, No. 9: 102. April, 1945.

The experience of a retail ice cream manufacturer who has been selling ice cream by weight for five years is cited. Paper trays, similar to those used for dispensing lard, are used for dispensing ice cream, then covering the ice cream with a piece of waxed paper, and finally slipping the tray of ice cream into a paper sack. Every package is weighed as sold. The advantages are: package is made up in less time than usual hand dipping, customers are better satisfied and better inventory control is maintained. J.H.E.

330. Factors Affecting Continuous Freezer Operation and Control. E. H. FORSTER, Cherry-Burrell Corp. Ice Cream Rev., *28*, No. 9: 42. April, 1945.

This article covers a number of the common troubles one is likely to encounter in the operation of the continuous freezer. Water and oil in the refrigeration system are the greatest cause of inefficient heat transfer. Freezer blades can also be responsible for low heat transfer. The easiest way to keep continuous freezer blades in proper condition is to touch them up with a fine mill file or oilstone after every two or three days of operation. The most important part of the blade to watch is the cutting edge to see that it does not wear to a sharp edge and then develop a burr or feather edge. Many continuous freezer operation and control problems are the result of under-freezing or conditions which cause difficulty in getting the ice cream stiff enough to permit thorough and uniform air incorporation. It must be realized in analyzing continuous freezer operation that air cannot be incorporated in the mix until it is partly frozen to a consistency where it will hold air. J.H.E.

MILK

331. Production, Demand and Price Trends for Dairy Products in the United States and Washington, Previous to 1944. H. A. BENDIXEN AND E. E. DUMMEIER, Washington Agr. Expt. Sta. Bul. *442*, 74 pp. March, 1944.

In this bulletin information has been presented about the production and consumption of dairy products in the United States and in the State of Washington. Changes in prices received by farmers for dairy products both in dollars and in comparison with other prices and living costs are also given. Some of the significant facts given in the bulletin may be summarized as follows: "(1) Highest total and highest per capita production and consumption of milk and its products in the United States occurred in 1942, when total production was about 122 billion pounds of milk and per capita consumption of dairy products in all forms amounted to the equivalent of about 850 pounds (roughly 100 gallons) of milk per person. (2) From 1932 to 1938 the total production and consumption of dairy products changed very little, which, with an increasing population, resulted in a decreased supply and decreased consumption per capita. From 1938 through 1942 production and consumption increased sufficiently to result in per capita consumption of all dairy products in 1942 about 6 per cent higher than the 1935–38 average. (3) In 1943, because of an 0.8 per cent decline from 1942 in the production of milk in the nation and because of the large diversion of dairy products from civilian use to military and lend-lease uses, the civilian consumption of all dairy products except fluid milk declined markedly. Total per capita consumption of all dairy products in milk equivalents in 1943 was much below any other year since 1930. (4) There has been a recent tendency to consume a greater portion of all dairy products in forms such as whole milk, evaporated milk, cheese, and milk powder, which include the non-fat milk solids as well as the fats. (5) The total consumption of dairy products in all forms is considerably greater for families with larger incomes than for families with smaller incomes. Per capita allotments to persons in the military services are considerably greater than quantities available to civilians. (6) The larger incomes resulting from "war prosperity" have caused a marked increase in the demand for dairy products. Because the supply was insufficient to meet the demand of O.P.A. fixed prices, either price increases or rationing were necessary. (7) The State of Washington has about the same number of cows per capita of population as the nation as a whole. But its production of milk and of butterfat per cow and also its total production of dairy products per capita of population are about one-third above the average of the nation. In the year 1942 Washington's production of milk on farms was 1,234 pounds per capita; that of the nation 914 pounds. In the same year the average per capita consumption of all

dairy products by the civilian population of the state was estimated at the equivalent of 1,016 pounds of milk compared with an average of 850 pounds for the nation. (8) From 1930 to 1942 the production of butterfat on farms in the nation increased 20 per cent, in the State of Washington 30 per cent. During these same years there was a greater percentage increase in the production of cheese, evaporated milk, and ice cream in this state than in the nation, but a greater percentage increase in the production of butter and non-fat dry milk solids in the nation than in the State of Washington. (9) During the depression, as represented by the year 1932, the prices received by the State of Washington farmers for dairy products and the average prices received by them for all farm products both dropped to about 60 per cent of the prices received by them from 1910 to 1914. Hourly earnings of factory workers in the nation in 1932, however, remained at 216 per cent of 1910–14 average hourly wages, and annual earnings of employed industrial workers at 160 per cent of 1910–14 earnings. Production of dairy products was maintained, however, in spite of unfavorable prices, because of limited opportunities for continuous other employment. Greatly in the interest of the public welfare, dairy producers and other farmers chose to work for low returns rather than not to work at all. (10) From 1938 to 1942 prices of dairy products relative to prices of other farm products were sufficiently attractive to lead to increased total per capita production of dairy products. (11) In 1943 the prices received for dairy products relative to earlier prices were among the most unfavorable of all farm product prices. The prices of feed and of hired labor in 1943 advanced sharply because of the competition of producers of other animal products for feed, and the competition of the war industries for labor. As a result, the total production of dairy products declined somewhat, and the total supplies available for the civilian population per capita were reduced over 9 per cent. (12) In the year 1943, under government control of prices, in comparison with the year 1928, representing the period of pre-depression prosperity, the prices of sour cream butterfat to farmers in the State of Washington were permitted to advance 4 per cent; the prices to farmers for all dairy products in the nation 15 per cent; the prices to the State of Washington farmers of all farm products 43 per cent; the hourly earnings of factory workers 75 per cent; and the average annual earnings of industrial workers 62 per cent; the urban cost of living after a decline in the depression years had only come back to the 1928 figure. (13) Desirable nutrition standards call for increased consumption of dairy products. Increased consumption requires increased production, and to secure such increased production requires prices for dairy products which are most favorable to the producers of dairy products in comparison with the opportunities of receiving incomes from other occupations than prevailed during most of 1943."

H.P.

332. The Mechanical Cow. GEORGE K. ANDERSON, Secretary, The Council on Foods and Nutr. of the Amer. Med. Assn. Cert. Milk, *19*, No. 224: 11. Dec., 1944.

The "mechanical cow" is a machine manufactured by the United Dairy Equipment Company of West Chester, Pa. The purpose of the machine is to mix water, spray-dried skimmilk, milk and butter to produce a product which can substitute for milk and cream according to the proportion of ingredients employed. Ice cream mixture can also be prepared by use of this machine. The machine is useful in supplying a good substitute for milk and cream on ships and in regions where dairies are inadequate or non-existent. W.S.M.

333. Planning for Postwar Personnel Problems. EARL WEAVER, Dairy Department, Mich. State Col., East Lansing, Mich. Milk Plant Monthly, *34*, No. 2: 28, 30, 32, 34–35. 1945.

Serious post-war dairy personnel problems are possible but not inevitable. The avoidance of them can hinge largely, but not entirely on the policies used now and in the future by the plant operators. Much labor will be needed in our dairy plants. Likely higher wages than formerly will be paid to dairy plant personnel. Loyalty and faithfulness in employees will be recognized. A dearth of college-trained dairy personnel exists. The industry is suffering from a dearth not only of trained men but also young men in the process of training. Well-trained dairy personnel must be given the opportunity for development in the dairy industry. Many returning veterans will wish to secure college training in dairying. The dairy departments in our colleges may be able to play effective rôles in post-war personnel problems. Dairy departments face the challenge of training men for the industry in which there will be a shortage of trained men for several years following the war. G.M.T.

334. Streamlined Milk Delivery Service an Economic Necessity. T. KLINE HAMILTON, Diamond Milk Products, Columbus, Ohio. Milk Plant Monthly, *34*, No. 5: 63–64, 67. 1945.

Wartime conservation of vital manpower, materials, and facilities has necessitated a reduction of one-half vehicle mileage gasoline consumption and man hours of milk distribution. Dairy units per truck and route men have doubled, and units delivered per milk and per man hour have trebled. Meanwhile route men have benefited by better working conditions, social advantages or daylight and no Sunday delivery, and lighter, smaller, convenient packages with hours of work reduced 20% and earnings doubled. The consumer has benefited by service requiring less of her time, a handier, lighter, more convenient package, lower percentage price increase in milk

than the average of all foods. The dealer has remained on approximately the same per unit spread. These economies necessitated by the war will carry on into the post-war period. Many questions concerning various economic problems will be considered. A high prosperity potential in the post-war period is inevitable. This will mean keen competition. The surviving business will be that which affords the best value and service in merchandising the product. Low operating costs will probably be the best competitive weapon. The dairy industry faces a real challenge to get more milk to more people at less cost. To fulfill the challenge the author suggests (1) promoting the maximum practical efficiency in the production, transportation, processing, selling and delivery of milk; (2) improving the quality of our products on the farm and in the plant; (3) maintaining a program of education and publicity to merchandise our product; and (4) carrying on a continuing program to tell our economic story that is so vital, yet so little understood. G.M.T.

335. Common Sources of Leaks and Waste in Plants. F. H. HERZER, Prof. of Dairy Mfg., Miss. State Col. Milk Dealer, *34*, No. 9: 131–132. June, 1945.

The author gives five classifications for losses based upon a plant handling 1000 gallons of milk per day which in a year's time would amount to $6,088.07. Products, power, supplies, equipment and personnel with itemized losses are listed as factors to consider in reducing leaks and wastes in dairy plants. C.S.T.

336. Federal Regulation of Milk. KARL P. SPENCER, Attorney, St. Louis, Mo. Milk Dealer, *34*, No. 8: 119–123. May, 1945.

The delegation by Congress of its constitutional legislative functions whereby Federal regulation of business by executive orders and through administrative agencies is accomplished is not new (June 4, 1794). The trend towards such delegation of authority and regulation, however, was accentuated with the advent of the world-wide depression in the 1930's. The importance of milk and its processing as a business and its importance in agriculture made Federal regulation of this industry inevitable. Ninety per cent of Federal regulations are now issued by Federal executive bureaus and 10% by Acts of Congress. The author cites Agricultural Adjustment Act with its amendments authorizing hearings and issuance of milk marketing orders as applicable to production and processing of milk and milk products with benefits and disadvantages of such orders in different markets. The legislative intent to control only interstate commerce is pointed out and court cases cited to show that apparent intrastate commerce has been interpreted to be amenable to existing milk marketing orders.

The problems involved in classification of milk and its products are discussed in the light of O.P.A. ceiling prices of producer, processor and handler of ice cream as a separate commodity and of maintaining "price priority" for producer and processor. The pricing of fluid milk by either rigid or flexible price controls with their economic and profit relationship between producer and processor is discussed. The author predicts rationing and price, wage and rent controls, continuation and tax adjustments favoring small business as a post-war factor in the milk business. C.S.T.

337. Postwar Operations Call for Streamlining. P. H. TRACY, Dept. of Dairy Husb., Univ. of Ill., Urbana, Ill. Milk Dealer, *34*, No. 9: 46–50. June, 1945.

In supplying the fresh milk needs of city dwellers the market milk plant operator as a middleman with responsibilities from the equality and service viewpoint and in his rôle of supplying an essential dietary need is comparable to a public utility. Streamlining plant operation and services should therefore be considered "as a project for continuous consideration." When delivery costs as much as 50% of the price paid the farmer, then such costs are probably unreasonably high. The author cites 8 reasons for high delivery costs, some of which, under existing conditions, such as union wages, size of load permitted and unnecessary health regulations, are largely beyond the control of the distributor. Others such as consumer demands as to degree of services deemed necessary, bottle and container losses and container costs are more amenable to change and control. The solution of high delivery costs is not simple though store selling, single service containers, improvement in glass containers to conserve space and weight hauled, every-other-day delivery, readjustment of drivers' wages as to volume of load and elimination of special deliveries insofar as is possible are partial solutions suggested. The results of a cost analysis of 92 different plants throughout the country are cited as basis of this conclusion; "Dealers with costs for receiving, processing, bottling, selling and delivery of milk to stores not greater than 2½ to 3 cents needed have little fear of post-war competition." Tables giving itemized distribution of wholesale cost of two efficient plants in this survey are given. C.S.T.

338. Wartime Milk Procurement Economies in Peacetime Operations. E. H. MATZEN, Extension Economist, State of Indiana. Milk Plant Monthly, *34*, No. 2: 26, 40. 1945.

Several economies have been effected during wartime in the procurement of milk and cream, some of which may well be carried on in the post-war operation. The major economies in assembling milk have come from (1) better organization and less duplication of the routes serving a given plant,

and (2) dropping off most distant producers and pulling the milk supply nearer the plant. Economies in cream procurement have come through (1) assembling less frequently from cream stations by limiting the days of operation, and (2) assembling every four days, rather than straight twice a week. As a result of necessity the dairy industry has had to make a study of its milk and cream routes which has resulted in economies as mentioned above. It was believed that (1) milk hauling would become a full-time job and the trucking business would be taken over by fewer owners, (2) that larger trucks would be used and the trucks would make more than one trip daily, (3) that more and more milk would be assembled in insulated trucks, and (4) that the hauler would be used more extensively as a field man, rendering more service in contacting the producer, and probably in the expansion of home freezing units. In post-war competition, economies affected through assembling of dairy products will be given even greater attention.

G.M.T.

339. Cleaning and Sterilizing Hot-Short Pasteurizers. C. M. Moore, Diversey Corp., Chicago, Ill. Milk Plant Monthly, *34*, No. 1: 62–65. 1945.

Inasmuch as hot-short pasteurizers involve the heating of milk to higher-than-normal temperatures and handle large quantities of milk in a comparatively small area of equipment, the cleaning of the equipment is probably more difficult than that of other types of dairy equipment. However, methods have been devised which will make possible clean equipment, maintained in that condition over a long period of time. The steps recommended for correct cleaning procedure of hot-short pasteurization are as follows: (1) Immediately after handling the milk, disconnect the flow diversion valve and shut off the hot-water pump. (2) Circulate cold water through the unit until the rinse water is free of any traces of milk and the entire unit is cooled down to room temperature. (3) Circulate water heated to 135° to 150° F. through the equipment. (4) Add special acid-base milkstone remover at a concentration of one pint to one quart to each 40 gallons of water used. (5) Circulate the milkstone remover slowly through the equipment for 30 minutes to one hour. (6) Following circulation of the milkstone-removing solution, float off accumulated contamination in the surge tank, running water from a hose into this tank for 10 to 15 minutes, pumping water from the surge tank through the equipment onto the floor. (7) Circulate alkaline-type milkstone remover through the equipment, usually two pounds for each 40 gallons of water. (8) Circulate this alkaline-type solution through a unit at 135° F. to 145° F. for thirty minutes to one hour. (9) Circulate cold water through the unit. (10) Dismantle the equipment and inspect, brushing the parts with a mild alkaline solution if necessary. (11) Rinse parts with warm water and reassemble. Sterilizing

treatment will be done the following morning by circulating a solution of 100 parts per million of available chlorine through the unit. Some variations of the above cleaning procedure may be necessary with some specific types of equipment. G.M.T.

340. Pros and Cons of Hot-Short Pasteurization. C. F. WEINREICH, Cherry-Burrell Corp., Chicago, Ill. Milk Plant Monthly, *34*, No. 1: 56, 58. 1945.

A brief history of the development of high-temperature–short-time pasteurization is given. This system of pasteurization was first accepted by the U. S. Public Health Service in 1933. Several types of equipment are now in use for high-temperature–short-time pasteurization. The advantages given for hot-short pasteurization are as follows: (1) Flexibility in increasing plant volume by longer running time by adding plates, and by having no part batches which require full holding time; (2) various jobs possible with same press, and often with same plates; (3) floor space saved; (4) flavor better; (5) decreases plant operating time; (6) quicker handling of late arrival milk; (7) no over-holding in case of shortage of cases or bottles, late delivery or breakdown; (8) can expand with same boiler capacity as regeneration saves 75% of steam; (9) regeneration saves cooling water; and (10) no incentive to reduce holding time.

The disadvantages given are as follows: (1) does not lend itself to small plant operations (plants pasteurizing with three vat pasteurizers or less are usually considered too small); (2) danger of freeze-ups when using cooling medium colder than 32° F. Special controls can prevent freeze-ups; (3) harder to handle special products; (4) more complicated (operator needs more training); (5) gaskets have been a source of trouble; (6) needs better milk having fewer thermoduric organisms.

Some sanitarians believe that the information on high-thermoduric counts in milk as the result of high-temperature–short-time pasteurization is an advantage in that more attention will be paid by the producer in producing high quality milk. G.M.T.

341. Hot-Short Pasteurizing Equipment from Operator's Point of View. H. A. PUTNAM, F. B. Mallory, Inc., Springfield, Mass. Milk Plant Monthly, *34*, No. 1: 33–34. 1945.

Operators of milk plants readily agree that a successful dairy must assure a finished product which meets public health standards and yet maintain a flavor which will be acceptable to the consumer. In accomplishing these results high quality of raw milk from approved farms is the first essential. This should be followed by effective pasteurization. High-temperature–short-time pasteurization has been acceptable from the public health standpoint and yields milk of an improved flavor.

Many advantages are given for the high-temperature–short-time system of pasteurization which include (1) less labor for operation; (2) filling started shortly after milk is received; (3) economy in floor space; (4) less milk is held over in case of a shut down; (5) continuous operation; (6) a better flavored milk; (7) the system is completely closed; (8) the system is flexible; (9) the system is automatic; (10) fewer errors in operation; (11) the equipment is neat in appearance; (12) less equipment to watch; (13) less time required for cleaning; (14) cost of operation reduced through regenerative principle; (15) present controls assure pasteurization; (16) milk uniformly pasteurized; (17) small steam boiler can be used; (18) no incentive for operator to reduce holding time on Sundays and holidays and (19) no inlet and outlet valves to leave open accidentally. Maintenance and adherence of gaskets is a problem in operation due to the type of rubber now available. This difficulty may be avoided in part at least with greater care in washing and assembling of parts. High-temperature–short-time pasteurization is adaptable to many plants. G.M.T.

342. Fieldman's Share in Producing Quality Milk. XVI. Shortcomings in Dairy Farm Operation and Recommendations for Improvement. H. L. PENDLETON. Milk Plant Monthly, *34*, No. 1: 30–32. 1945.

A survey of the factors involved in clean milk production show a tendency toward laxness in certain phases of clean milk production during the war years. Particularly was this true in cleanliness of the herd, disposal of manure, stable sanitation, ventilation, cleanliness of utensils and the cooling of milk. On the other hand, dairymen whose farms are consistently approved on first inspection year after year habitually practice good clean milk production.

Suggestions for improvement of the milk supply involve (1) keeping cattle healthy, (2) maintaining cleanliness of herd through use of absorbent bedding and through clipping of the flanks and udder of milking cows, (3) daily removal of manure, (4) cleanliness of stable through regular sweeping and application of superphosphate and whitewashing periodically, (5) cleanliness of milk room through daily washing and maintenance of floors, walls and interior, as well as changing the water in the cooling tank periodically and (6) use of adequate cooling facilities and cleanliness and sterilizing of all utensils. Special emphasis must be placed upon the cleanliness and sterilization of utensils as these play an important rôle in high quality milk production. G.M.T.

343. Some Recent Developments in the Connecticut Milk Markets. I. Milk Production and Consumption Trends. ALAN MACLEOD AND D. A. CLARKE, JR. **II. The 1943 Emergency Milk Purchase Pro-**

gram. D. O. HAMMERBERG AND W. G. SULLIVAN. Storrs Agr. Expt. Sta., Bul. *254*, 40 pp. March, 1945.

I. Fluid milk consumption in Connecticut markets increased from 521,000 quarts per day in 1938 to 752,000 quarts per day in 1944, while total receipts of milk increased from an average of 660,000 quarts per day in 1938 to 802,000 quarts in 1944. Receipts for 1944 included an average of 130,000 quarts per day from regular and emergency sources outside of Connecticut. A very tight market resulted from increased consumption and a more than normal seasonal decline in production. Total receipts were only 0.9 million pounds in excess of class I sales.

It is apparent that the demand for fluid milk in Connecticut in the post-war period will be greatly conditioned by the general levels of industrial activity and wages. A post-war industrial recession may create a real burden of surplus milk.

II. The narrowing spread between Class I sales and receipts from the regular milkshed that characterized Connecticut markets for several years was brought to a climax by the abrupt drop in production during the fall of 1943. There were three possible courses of action for the dairy industry of the state to take. First, it would have been possible to curtail consumption. Second, it might have been possible to expand the regular milkshed. Third, it was possible to coordinate the emergency importations of milk, to expand the volume of the emergency imports, and to devise some equitable scheme for allocating this milk among markets and dealers.

The first proposal was not tried. The second alternative, expansion of the regular milkshed, had been progressing for several years and was continued. A large group of dealers decided to try the third suggestion and set up a formal purchase and allocation program. The program operated for seven weeks and allocated about 90 per cent of all emergency milk brought into the state besides regularly inspected sources that were made available for allocation.

The emergency milk purchase program of 1943 illustrated the ability of the Connecticut dairy industry to serve the public interest through coordinating efforts and incurring expenses that in many cases were not justified by any selfish consideration of self-interest or immediate profit. This experience should prove valuable here and in other states if similar circumstances arise again. H.P.

344. Efficiency of Milk Marketing in Connecticut. 8. Possible Milk Delivery Economies in Secondary Markets. S. K. SEAVER AND R. G. BRESSLER, JR. Storrs Agricultural Experiment Station, Bul. *252*, 68 pp. May, 1944.

The studies of secondary markets in Connecticut confirm the inefficiency in milk distribution and stress the importance of route duplication, cross

hauling and excessive truck and labor capacity. Although the delivery system was improved by alternate-day delivery, the elimination of special deliveries and pressure on manpower, very significant improvements are still possible but would involve public or private monopoly in distribution and plant operation.

Truck travel with alternate-day operations was reduced to 380 feet per quart of milk delivered in the markets studied. Immediately preceding the war this figure was 630 feet per quart of milk. Market zoning and exclusive delivery territories would make possible daily delivery with truck travel of about 150 feet per quart and alternate-day delivery with 100 feet per quart.

The conservation of resources is tremendous in milk delivery economics. With the adoption of alternate-day delivery, annual truck travel was reduced nearly four million miles and there were savings of about 500,000 gallons of gasoline, 20,000 quarts of oil, and 800 truck tires. If alternate-day delivery were to be combined with exclusive delivery territories, an additional four million miles would be saved.

Under organized conditions discussed in the bulletin it would be reasonable to expect that milk distribution costs would be reduced. Total costs of city distributors would average between 3.5 and 4.8 cents per quart, compared with the present margin of more than seven cents. To bring about these economies in the post-war period would require a major reorganization of the industry. The bulletin has a selected bibliography on milk distribution efficiency. H.P.

345. Efficiency of Milk Marketing in Connecticut. 9. Conservation Possibilities in Retail Delivery in Major Markets. R. G. BRESSLER, JR., D. A. CLARKE, JR., AND S. K. SEAVER. Storrs Agr. Expt. Sta., Bul. *253*, 46 pp. Aug., 1944.

This bulletin is the third in a series dealing with the efficiency of retail milk delivery in Connecticut. This study is concerned with the major markets and presents the results obtained for the cities of Hartford and New Haven.

In the period prior to the war, milk delivery routes in Hartford traveled more than 5000 miles per day in an area with only 184 miles of city streets. Alternate-day delivery and the elimination of special deliveries reduced truck travel to approximately 3000 miles per day. If the city were divided into exclusive delivery areas with one dealer assigned to each area, daily delivery could have been made with only 500 miles and alternate-day delivery with only 334 miles of route travel. If all deliveries were made from a single centrally located plant (public utility), route miles would be slightly higher than those for exclusive territories because of the increased average length of haul.

Conditions in the New Haven metropolitan milk market resembled those

in Hartford. Studies of the operations of nine New Haven dealers who deliver about 80 per cent of all milk in the market indicate that their present route mileage could be reduced 75 to 80 per cent through allocated territories. Three small dealers handling less than five per cent of the market total could reduce their present mileage more than 40 per cent by exchanging 30 per cent of their customers and thereby eliminating the duplication of their routes. H.P.

PHYSIOLOGY

346. The Relative Thyroidal Potency of l- and d,l-Thyroxine. E. P. Reineke and C. W. Turner, Univ. of Missouri. Endocrinology, *36*, No. 3: 200. March, 1945.

The crystalline l-thyroxine assayed was taken from a lot isolated from iodinated casein subsequent to hydrolysis with sulfuric acid and the crystalline d,l-thyroxine was obtained by isolation from iodinated casein after hydrolysis with barium hydroxide. Chick trials were conducted with White Plymouth Rock male chicks when about 48 hr. old. A second trial was made on male and female albino rats of the Missouri strain. A third trial was made on frog tadpoles (*Rana pipiens*). The comparative thyroidal activity of l- and d,l-thyroxine was determined by their relative ability to reduce the thyroid weight of thiouracil-treated chicks and rats and by their ability to stimulate metamorphosis in frog tadpoles. It was found that l-thyroxine produced twice the effect of racemic mixture in every species tested. It was concluded that all the activity of racemic thyroxine could be accounted for by its l-component and that the d-compound had little or no activity.

R.P.R.

347. The Galactopoietic Action of Pituitary Extracts in Lactating Cows. I. Dose-Response Relations and Total Yields During Declining Lactation. S. J. Folley and F. G. Young, Univ. of Reading and the Natl. Inst. of Med. Res. Jour. Endocrinology, *4*, No. 2: 194. Jan., 1945.

Eighty-five cows in declining lactation were used in the experiments. The minimum effective dose of a crude aqueous extract of fresh anterior-lobe tissue was found to be about 2.5 gm.-equivalent of fresh tissue. This dose, given as a single injection, gave a net increase in milk yield of 7.7%. A substantial increase in milk production was obtained with 2.5 and 1.25 gm.-equivalent of fresh anterior lobe tissue when injected at 2-day intervals for 21 days. An extract prepared from whole ox-pituitary gland, an extract of fresh anterior lobe tissue which remained at room temperature for 24 hr., and an extract of acetone-desiccated anterior-lobe tissue were all not obviously less effective than a standard extract of fresh ox anterior-lobe tissue.

Extracts of ethanol-desiccated anterior lobe tissue were almost inactive. Neither a single injection nor repeated injections of an extract prepared from whole ox-pituitary gland had no deleterious effect on pregnant cows. R.P.R.

348. The Galactopoietic Action of Pituitary Extracts in Lactating Cows. II. The Response During the Peak of Lactation. H. T. Fawns, S. J. Folley, and F. C. Young, Lab. Dartington Hall Trustees, Univ. of Reading and the Natl. Inst. for Med. Res. Jour. Endocrinology, *4*, No. 2: 205. Jan., 1945.

A total of 15 South Devon cows at or near the peak of lactation were used in the experiments. Extracts injected were either a standard crude alkaline extract of fresh ox anterior-pituitary tissue or a similar extract of acetone-desiccated ox anterior lobe. In each case the material extracted from 2.5 gm. of fresh anterior lobe tissue or 0.5 gm. of desiccated gland was contained in 10 ml. of extract, the dose used throughout the experiments. Two cows in the 7 weeks after calving showed no increase in milk production in which 10 ml. of pituitary extract was administered 33 and 46 days respectively after calving. Repeated injections of extract at 2-day intervals during the 7 weeks of steady milk production following calving failed to increase milk production. Two cows treated with pituitary extract for about 5 weeks before calving and for 3 weeks after calving were thought to have secreted more milk at peak production than they might have otherwise. Two cows which received repeated injections of pituitary extract for 3 weeks within 3 weeks of abortion showed increases in milk production. R.P.R.

349. The Galactopoietic Action of Pituitary Extracts in Lactating Cows. III. Comparison of Extracts of Pituitary Glands from Different Species. S. J. Folley, F. H. Malpress, and F. G. Young, Univ. of Reading and the Natl. Inst. for Med. Res. Jour. Endocrinology, *4*, No. 2: 212. Jan., 1945.

Twenty-four Shorthorn cows in declining lactation were used in the experiments. All the extracts used were prepared from acetone-desiccated anterior-lobe tissue by extraction with saline at pH 8.5. The final concentration was such that 10 ml. contained the material which had been extracted from 0.5 gm. of tissue. A single injection of 10 ml. of horse pituitary extract was slightly more effective in stimulating milk production than was 10 ml. of ox pituitary extract. Sheep and pig pituitary extract showed no activity following a single injection of extract. Groups of cows treated at 2-day intervals for a period of 17 days with sheep and hog anterior-pituitary extracts showed a substantial and sustained depression of milk production. The possibility was considered that this fall was the result of rapid anti-hormone formation to heterologous glandular material. R.P.R.

350. Induction of Lactation in Goats and Cows with Synthetic Oestrogens and Anterior-Pituitary Extracts. S. J. FOLLEY, F. H. MALPRESS AND F. G. YOUNG, Univ. of Reading and the Natl. Inst. for Med. Res. Jour. Endocrinology, *4*, No. 2: 181. Jan., 1945.

Attempts were made to initiate lactation in goats and cattle by a combined treatment with synthetic estrogen and a crude alkaline extract of ox pituitary. Two goats were given 3 udder inunctions weekly with one gm. of one per cent of diethylstilbestrol ointment. In one goat only traces of secretion were obtained following estrogen therapy but the injection of 5 ml. of anterior-pituitary extract on alternate days at once brought the goat into lactation and the yield quickly rose to a daily peak of almost 1700 ml. Cessation of anterior-pituitary treatment was followed by a rapid fall in daily milk yield to a level of about 900 ml. A second goat came into lactation soon after inunction began and reached a peak daily yield of 500 ml. Injections of 5 ml. of anterior-pituitary extract on alternate days resulted in an increase to a new daily maximum of almost 900 ml. Additional experiments with virgin goats showed that simultaneously treating them with estrogen and ox anterior pituitary extract induced lactation sooner than treatment with estrogen alone. In 2 out of 5 experiments on cows or goats in which prolonged estrogen treatment failed to induce lactation, the institution of anterior-pituitary injections resulted in the initiation of lactation. Anterior-pituitary extract increased the level of milk production when injected at the peak of lactation induced by estrogen treatment in virgin heifers or goats.

R.P.R.

351. Induction of Lactation in Heifers by a Single Injection of Esters of Diethylstilbestrol. A. S. PARKES AND R. E. GLOVER, Natl. Inst. for Med. Res., London. Jour. Endocrinology, *4*, No. 1: 90. July, 1944.

All of the heifers used in the experiment were of the Ayrshire breed, about 15–18 months old at the start of treatment. Seven heifers were used in Exp. 1 and they were given a single injection of an ester of diethylstilbestrol. Six of seven heifers gave a recordable amount of milk at some stage. The best response was given by a heifer injected with 250 mg. of diethylstilbestrol dilaurate, and she attained an average daily yield of 12.4 lb. in the 10th week after injection. Following treatment, 6 of the 7 heifers were allowed to run with a bull. A rectal examination 3 months thereafter showed 3 heifers to be pregnant and the remaining 3 had active ovaries but were not pregnant. In Exp. II 10 heifers received a single injection of an ester of diethylstilbestrol, 50 mg. to 1.0 gm. Only 2 heifers receiving diethylstilbestrol dipalmitate gave a daily average for a week of more than 2 lb. and 6 never gave as much as one pound. Nine heifers were mated and 7 conceived.

In a third experiment 7 heifers were injected simultaneously with a slowly acting and a rapidly acting ester or free diethylstilbestrol. Diethylstilbestrol dilaurate and the dipalmitate in association with the dipropionate or the free substance were used. Dosage of the former was kept constant (250 mg.); that of the latter was varied from 50 mg. to 250 mg. The best yield, a daily average in the 15th week after injection of 13 lb., was obtained from a heifer injected with 250 mg. of diethylstilbestrol dilaurate and 250 mg. of diethylstilbestrol dipropionate. Milk analyses showed that the fat content was above legal minimum in all samples and was definitely high in some. The S–N–F content was normal to high. R.P.R.

352. Oestrogen Excretion in Milk from Oestrogenized Cattle. W. Lawson, S. W. Stroud, and P. C. Williams, Middlesex Hospital, London. Jour. Endocrinology, *4*, No. 1: 83. July, 1944.

Small amount of hexestrol (1–2 μg./pt.) added to normal milk was extracted with ether or acetone with 60% to 100% recovery. The amounts of estrogen present in the milk from heifers treated with synthetic estrogens was too small for assay by direct feeding to rats even if the rats were fed entirely on milk. Samples of experimental milk were extracted and roughly assayed by subcutaneous injection or intravaginal application in ovariectomized rats. The results obtained using a continuous ether extraction method showed the estrogen content per pint of milk to vary from 0.01 μg. to 0.5 μg. Single determinations on the blood and urine of a heifer receiving 20 to 24 mg. of dienoestrol daily by mouth gave estrogen concentrations of 5 μg. per liter of blood and 2 mg. per liter of urine. R.P.R.

353. Oestrogen Treatment of Cattle; Induced Lactation and Other Effects. J. Hammond, Jr. and F. T. Day, Cambridge University. Jour. Endocrinology, *4*, No. 1: 53. July, 1944.

One hundred and forty heifers and cows were given estrogen treatment, nearly all with tablet implants of stilbestrol or hexestrol. Observations were made on changes in ovaries, reproductive tract, udder, and behavior. During treatment follicular growth ceased and occasionally the corpus luteum persisted. After removal of the implant follicular growth began and ovulation resumed, sometimes after a transient period of follicular cysts. An increased frequency of double ovulations was noted. After the corpus luteum regressed irregular heats were observed, the frequency and intensity of these varied greatly and in a few animals behavior seemed characteristically male. Relaxation of pelvic ligaments together with repeated mounting sometimes led to pelvic fractures. The heifers used in the experiment were ones which had failed to conceive and after treatment a number of those with normal organs were mated and a large proportion conceived. Mam-

mary growth occurred in heifers and drying off of lactation and its initiation in cows and heifers followed implants of estrogen tablets. In the presence of a persistent corpus luteum initiation of milk secretion was suppressed. Lactation did not result in every case and in a number of cases the volume of secretion was low. The highest mean daily yield in a week was 30.1 lb. which occurred in one heifer during the 10th week following implantation. The highest total yield was that of a treated heifer which produced 9808 lb. of milk in 58 weeks. This heifer developed cystic follicles after several estrous cycles. Milk records were not complete but over 130 tons of milk were produced. R.P.R.

354. Experiments on the Use of Tablets Containing 50% Hexoestrol for the Artificial Induction of Lactation in the Bovine. S. J. Folley, D. L. Stewart, and F. C. Young, Univ. of Reading, Seale Hayne Agr. Col., and the Natl. Inst. for Med. Res.; London. Jour. Endocrinology, *4*, No. 1: 43. July, 1944.

Experiments were carried out on the use of subcutaneous implants of tablets containing 50% hexestrol, 49% lactose, and 1% stearic acid for induction of lactation in 8 South Devon nulliparous heifers and 4 dry cows. In the heifers the maximum daily yield varied from 100 ml. to 21 lb. and the duration of recorded lactation varied from 24 to 45 weeks. In the dry cows the maximum daily yield varied from 0.75 to 25.5 lb. and the duration of recorded lactation varied from 9 to 71 weeks. The responses of 6 heifers producing small amounts of secretion to additional implants consisting of pure hexestrol tablets were also variable. In 2 heifers marked increases in yield resulted. Nymphomaniac symptoms were observed in all animals but none suffered pelvic fracture. Of 6 animals retained for breeding after cessation of treatment, 5 became pregnant following one mating. When implants consisted of 50 mg. tablets, containing 50% hexestrol there was a tendency for some of the tablets to become broken in situ, but not to any greater extent than small tablets of pure hexestrol. Tablets containing 50% hexestrol were absorbed more slowly than pure hexestrol tablets of similar size. R.P.R.

355. The Chemical Composition of Bovine Mammary Secretions Induced by the Subcutaneous Implantation or Oral Administration of Synthetic Oestrogens. S. J. Folley and F. H. Malpress, Univ. of Reading. Jour. Endocrinology, *4*, No. 1: 37. July, 1944.

Changes in milk composition were recorded for 15 heifers receiving synthetic estrogen either as implants or orally. Composite milk samples for analysis were prepared by mixing samples taken at the morning and afternoon milkings. With the exception of 2 heifers the first sample analyzed in each individual series was the first measurable sample withdrawn from that

animal. The mammary secretions of heifers brought into lactation by treatment with synthetic estrogens were at first colostral in nature but the composition gradually changed to that characteristic of milk of good chemical quality at a rate roughly proportional to the rate of increase in yield. In general the daily yield of 5 lb. could be regarded as a guarantee of normal composition. R.P.R.

356. Artificial Induction of Lactation in Bovines by Oral Administration of Synthetic Oestrogens. S. J. FOLLEY AND F. H. MALPRESS, Univ. of Reading. Jour. Endocrinology, *4*, No. 1: 23. July, 1944.

In a preliminary experiment 8 heifers were given daily doses of hexestrol or dienestrol total dose 3.3 to 18.2 gm., in their grain ration or drinking water. Maximum daily yield varied from 4.3 lb. to 18 lb. A further experiment involved 32 heifers in which either diethylstilbestrol or dienestrol, 8.1 gm. to 32.3 gm. total dose, was fed daily. Only 19 of the 32 heifers secreted milk and in these 19 heifers the maximum daily yield varied from 2.3 lb. to 19 lb. The milk yields generally were inferior to those given in the implantation experiments previously reported and far more estrogen was required to evoke responses. The general condition of the heifers suffered in no way from the treatment and symptoms of nymphomania were not marked. No heifers suffered from fracture of the pelvis or femur but 4 heifers showed periodic prolapse of the vagina. Within 2 months of the beginning of estrogen feeding the ovaries of every heifer examined (32) had become inactive. Over a period of some 2 months after treatment the ovaries of about 25% of the heifers contained either small cysts or possible large follicles. In many cases corpora lutea were present at this time. Of the 32 heifers in the second experiment 23 calved normally to services following cessation of treatment. It was estimated that in the bovine the oral administration of synthetic estrogens results in utilization of less than 10% of the amount given. The special problems presented by rumen activity and incomplete absorption from the alimentary canal were considered. R.P.R.

357. The Artificial Induction of Lactation in the Bovine by the Subcutaneous Implantation of Synthetic Oestrogen Tablets. S. J. FOLLEY AND F. H. MALPRESS, Univ. of Reading. Jour. Endocrinology, *4*, No. 1: 1. July, 1944.

An investigation was made of the application of the tablet implantation technique to the problem of estrogen-induced lactation in nulliparous heifers and dry cows which were barren. Lactation was induced by the subcutaneous implantation of large numbers of small tablets of either diethylstilbestrol or hexestrol. Individual variations in response were large, but in some cases the lactation curve was similar to that of a normal lactation curve. The best response was obtained with a dry cow which gave a maximum daily yield of

30 lb. and a total yield of 7395 lb. in 365 days. Implants totalling 5.0 and 2.5 gm. were equally effective, and there appeared to be little difference in efficacy between diethylstilbstrol or hexestrol. Lactation was induced in one of two treated freemartins with a peak daily yield of 15 lb. Lactation was also induced in 4 of 10 animals by the subcutaneous implantation of one or two tablets of hexestrol weighing approximately 1 gm. Maximum daily yield was 25 lb. The main drawbacks associated with the use of implants consisting of large numbers of small tablets were tablet fragmentation and migration. Neither drawback was noted when large tablets were used. Implanted diethylstilbestrol tablets were absorbed faster than those of hexestrol. Estrogen treatment was usually accompanied by a nymphomaniac syndrome which, in 20% of the cases in which small tablets were implanted, culminated in pelvic fracture. R.P.R.

358. Fracture of the Pelvic Bones in Bovines Implanted with Tablets of Synthetic Oestrogens. A. T. Cowie, Univ. of Reading. Jour. Endocrinology, *4*, No. 1: 19. July, 1944.

Pelvic fractures were observed in 2 cows and 5 heifers which had been implanted with tablets of synthetic estrogens. X-ray examination was made of the pelvic bones of 3 animals. No evidence of rarefaction was found in the bones and in the case of 2 animals the cortical bone appeared slightly more dense than in control bones. Chemical analyses of bone samples taken from the same region of the shafts of the ilia showed no significant difference between the control and experimental group. It was suggested that trauma from persistent coital mimicry was responsible for the fractures with the changes in pelvic morphology as a predisposing factor. R.P.R.

359. Absorption, Distribution and Excretion of Thiourea. R. H. Williams and Gloria A. Kay, Thorndike Memorial Laboratory and the Dept. of Medicine, Harvard Medical School. Amer. Jour. Physiol., *143*, No. 5: 715. May, 1945.

The contents of the paper are clearly stated in the title. D.E.

360. Stimulation of Livability and Glycolysis by Additions of Glucose to the Egg Yolk–Citrate Diluent for Ejaculated Bovine Semen. G. W. Salisbury and N. L. Vandemark, Dept. of Anim. Husb., Cornell Univ. Amer. Jour. Physiol., *143*, No. 5: 692. May, 1945.

The livability of bovine semen was increased by adding glucose to semen diluted at the rate of 1 part of semen to 4 parts of yolk-citrate diluent. Although glucose disappeared from the sample during storage, it was not proven that the spermatozoa used the glucose as a source of energy. D.E.

MISCELLANEOUS

361. Self-contained Boiler Units. A. W. RUFF, V. Pres. in Charge of Engineering and Development, York Shipley, Inc. Milk Dealer, *34*, No. 8: 48–52. May, 1945.

Self-contained, factory-assembled, boiler-burner units combined into one compact unit are said to (a) be more economical, (b) require less maintenance and service, (c) suffer less depreciation, (d) have lower initial cost, (e) have more flexibility and (f) require less space. By special designing to vary burner head and auxiliary equipment different fuels may be utilized in the one unit. They may be installed quickly and if necessary coordinated with existing installation. Automatic controls assure more economical operations, as they eliminate chimneys, and because they may be installed close to the machinery requiring steam thus eliminate long steam mains. The possibility of breaking up the steam generating plant into small units—10 H.P. or less—will effect further economies in labor, fuel, insulation, installation, combustion, heat-leakage losses and in cleanliness of plant operation in the newly designed steam-generating units. C.S.T.

362. Air Sanitation in Dairies and Food Plants. A. R. DENNINGTON, Westinghouse Lamp Div., Bloomfield, N. J. Ice Cream Field, *45*, No. 6: 47, 48, 50. 1945.

The author claims that ultraviolet irradiation units can be installed to advantage in dairy barns, ice cream and milk processing plants; cold storage lockers and food packing plants as a means of improving the sanitary quality of the foods handled. It is claimed that in milking barns, and milk rooms continuous irradiation during operation can be obtained by mounting Sterilamps on the ceiling, allowing one 30-inch lamp for about 100 square feet of floor space.

In ice cream plants it is claimed that ultraviolet irradiation will reduce the bacteria count by more than 60 per cent, if suitable irradiation is provided as the mix flows over a surface cooler. Installing Sterilamps on the inner side of the surface cooler covers is the procedure recommended. It is further recommended that paper or metal containers for storage and delivery of ice cream can be sanitized and the bacteria count reduced by irradiating empty containers just before filling them.

During the cooling period in locker plants, ultraviolet irradiation should be provided, the author states, but in rooms where leafy vegetables are stored, direct irradiation of the leaves for several hours causes brown spots to appear.

The author concludes that the use of ultraviolet irradiation in any food-handling establishment provides an environment which minimizes air-borne contamination and reduces surface bacteria and mold. He also considers the small amount of vitamin D radiation to be beneficial. W.C.C.

363. Insect and Rodent Control in Dairy Plants. D. M. DeLong, O.S.U. Ice Cream Rev., *28*, No. 8: 54. March, 1945.

This is a concise review of the best methods to use for eradicating insects and rodents from dairy plants. J.H.E.

364. Apprentice Training in the Dairy Industry. Walter F. Simon, Madison, Wisc. Ice Cream Rev., *28*, No. 5: 27. Dec., 1944.

The G. I. Bill of Rights provides for an apprentice training program for war veterans who wish to learn a profession or trade. After the training program is approved by the Industrial Commission the trainee receives a monthly payment from the government as well as the regular wages from the employer. The plan for the dairy industry is briefly described in this article. J.H.E.

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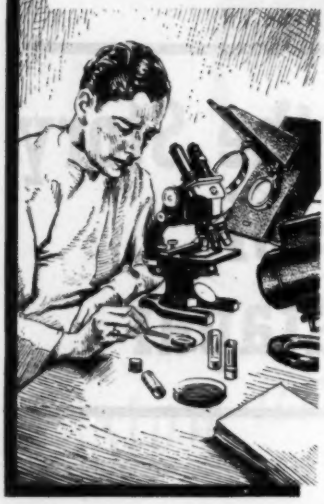

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(d) How many people in the United States know dextrose is a food-energy sugar? { 25,000,000 / 50,000,000 / 100,000,000 }

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Membership. Any person is eligible to membership who is formally announced by an Agricultural College or Experiment Station, or by the Bureau of Dairy Industry of the United States Department of Agriculture or by the Canadian Department of Agriculture as an instructor, extension worker, investigator, or administrative officer connected with the dairy industry, or any person filling a position of responsibility connected with the dairy industry who has had a college or university training in technical science, or any person filling a responsible position in the dairy industry of a professional character requiring a technical knowledge of dairying of a high order. The membership fee is $5.00.

The dues are $5.00 a year, $3.00 of which is for a year's subscription to the *Journal of Dairy Science*. Correspondence regarding membership and dues should be addressed to R. B. Stoltz, Ohio State University, Columbus, Ohio.

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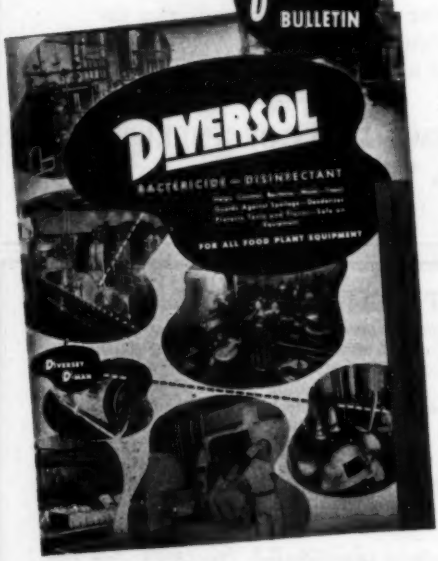

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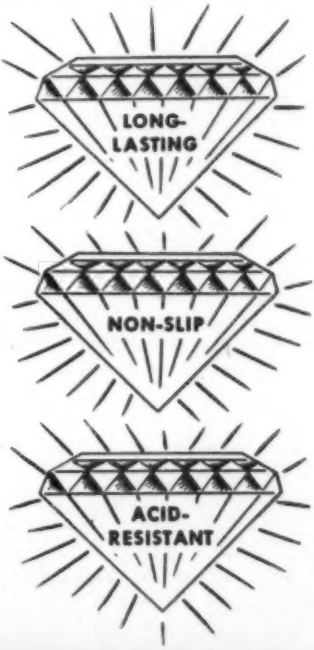

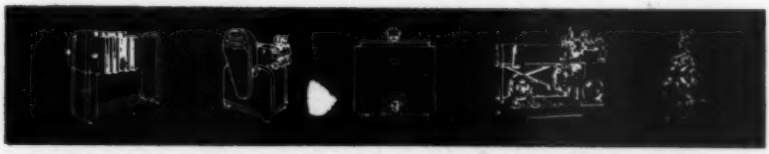

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